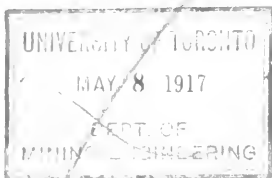


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EDITORIAL



T. A. RICKARD, *Editor*

OIL PRODUCTION of the United States is estimated to be at the rate of 800,000 barrels daily, equal to 292,000,000 barrels per annum. In 1915 the total was 291,400,000 barrels, but the marketed production was only 267,400,000 barrels. At the present time there exists a good market for all grades of petroleum products.

A STATEMENT has been made, and widely published, that on account of European capital being unavailable to continue work at certain California mines, there are 1000 less miners employed in this State than formerly. While sundry prospecting operations depending on foreign capital may have been suspended or reduced, there has been a noteworthy increase in the number of men employed in re-opening old mines, starting new mills, besides an expansion of operations at antimony, chrome, copper, lead, magnesite, manganese, tungsten, and zinc mines throughout California. Such increases largely exceed suspensions. The Industrial Accident Commission reports that at mines, mills, quarries, smelters, dredges, and cement plants there are 13,000 men employed, and gains are continually being reported. A similar expansion is in progress in the West generally.

RUMORS are current on Wall Street that "a billion-dollar copper merger" is to be organized for the purpose of consolidating or combining, in a manner not described, all "the big copper mines of the West and Alaska." We believe this to be untrue, for no sound economic basis exists for such an agglomeration. The copper-company units are big enough. Some of them—like the Kennecott affair—are already more conducive to stock manipulation than to cheapness of operation. Any idea of controlling the price of the metal by restriction of output or domination of the market is preposterous, having in mind the two previous abortive efforts to do so. If the Secretan syndicate failed in 1899 when the world's copper production was only 476,000 metric tons, what chance of success is there now with an output of over 1,200,000 tons per annum? We assume that the talk is made in order to excite speculation.

WESTERN Australia, as a State in the Commonwealth, endeavors to assist mineral exploration by means of money grants, the erection of stamp-mills for treating small lots of ore, and by geological surveys. In the end, however, the best work is done by private and corporate enterprise. The latest phase of systematic prospecting is credited to the Sons of Gwalia, a mining

company that produces \$100,000 in gold monthly. This company is equipping parties to prospect for gold and other metals. The men are paid wages with a contingent interest in anything that they find. Something is needed to sustain the gold production of the Australian commonwealth, for a steady decline is reported officially. During the first quarter of the current year the yield from the six States was 404,260 ounces, as against 477,410 ounces during the same period of 1915 and 875,000 ounces ten years ago. Western Australia showed a decrease of 41,841, to 255,948 ounces, in the quarter mentioned. This compares with 460,000 ounces in the first quarter of 1906.

IMMIGRATION is increasing slightly. In December 1914, also in January and August 1915, the admissions were less than the departures, but in April 30,560 arrived as against 4082 that departed. In April 1914, before the War, the arrivals numbered 119,885 and the departures 22,801, a gain of 97,084. This question of immigration plays an important part in fixing the price of labor, especially on the Atlantic seaboard. During the 21 months preceding the War, 2,102,360 immigrant aliens were admitted to the United States and 538,850 departed; in the ensuing 21 months, 503,364 were admitted while 293,644 departed. Nobody can predict confidently what effect the War will have upon immigration; whether the work of reconstruction will find occupation for ex-soldiers, as well as the many women now so usefully employed, or whether the disintegration and penury of large masses of population will cause them to seek new opportunities on the American continent, and, if they do so, whether they will come to the United States, or to Canada and South America.

UNITED VERDE EXTENSION Mining Co., the shares of which have risen to \$30 from a par value of 50 cents, had many hard knocks before success was achieved. The company was organized in 1894, and early work on the claims at Jerome proved so futile that the promoter committed suicide. Later the Red Rock mine near Providence, also in Yavapai county, Arizona, was acquired without successful result, and relinquished. In 1902 the United Verde Extension Gold, Silver & Copper Mining Co. was re-organized into the company of the present name, and in 1912 another re-organization took place. The *Boston News Bureau* estimates that the high price of \$30 per share will just repay the principal to the old stockholders of 16 years record, without considering interest. In 1913 the mine had about one mile of underground openings, and showed "a little ore of 267

copper, 1 oz. silver, and \$3 gold on the 800-ft. level." At the end of 1915 the bonanza, an orebody 250 feet square of 17½% copper, was uncovered. The president of the company is Mr. James S. Douglas, the son of Mr. James Douglas, the distinguished president of Phelps, Dodge & Co., New York.

GODFREY M. HYAMS is the name of the stockholder who has brought suit in the United States court to restrain the sale of the Tamarack mine to the Calumet & Hecla company. He charges that in the proposed sale, the Calumet & Hecla is acting both as vendor and purchaser, because this company already owns 19,400 shares of Tamarack stock, nearly one-third of the total issued. Mr. Hyams claims that the property is worth \$6,000,000 instead of the \$3,563,486 offered by the Calumet & Hecla. This is not the first time that Mr. Hyams has blocked the financial schemes of the Michigan copper companies. By means of his scattered holdings of stock he has opposed nearly every important move made by the Calumet & Hecla company during recent years. His ownership in the Tamarack mine is 1300 shares, which would be worth, at the \$59 offered by the Calumet & Hecla, \$76,700. It is not evident what Mr. Hyams gains by so many law-suits; but he is not unique; in nearly every mining region a similar type of man exists, a consistent opponent of combination and organization. Some people love to thwart others; they are born cantankerous. Others engage in battle to defend the down-trodden, for example, minority shareholders. We do not know to which category Mr. Hyams belongs.

TUNGSTEN is quoted at \$30 per unit and France is reported to be buying the metal. The following list of buyers and manufacturers of ferro-tungsten may prove useful to some of our readers: in Pennsylvania, the Primus Chemical Company, at Primus; the Vanadium-Alloys Steel Company and the Manhattan Reduction Company, both at Latrobe; the York Metals and Alloys Company, at York; the Bethlehem Steel Company, at South Bethlehem; the Crucible Steel Company of America, at Pittsburg; the Midvale Steel Company, at Philadelphia; and the Eirth-Sterling Steel Company, at McKeesport; at New York is the Goldschmidt Thermit Company, at 120 Broadway. Among brokers dealing in tungsten ores are the Foote Mineral Company, at Philadelphia; E. P. Earle, Charles Hardy, and Arthur Seligman at New York. Some of the steel companies buy ore as well as ferro-tungsten. The recent recession in price is due primarily to the decreased business in munitions. When the placing of contracts for munitions was at its height, there was a heavy shortage of high-speed tool-steel, so that an inordinate demand for ferro-tungsten was incited. Just now new contracts for munitions are few, so that some manufacturers find that they had overbought tool-steel. Fresh foreign business is pending and a strengthening of the market is anticipated, but the boom prices of a few months ago must be considered a thing of the past. Those are wise that base the

success of their operations on a price nearer that existing before the War than even the present reduced quotation.

LEAD is produced in large quantity by three States, Missouri, Idaho, and Utah. Their production in 1915 was 195,634 tons, 160,680 tons, and 106,105 tons, respectively. Colorado was a poor fourth with 32,352 tons. The great bulk of Missouri's output comes from the south-eastern part of the State, where a half-dozen companies work on 3 to 4% disseminated ore. The characteristic of this district is that lead alone, without zinc, is produced. Idaho's production comes from the lead-silver-zinc ores of the Coeur d'Alene. During some years the output of this region has exceeded that of Missouri. Utah's production has risen steadily during recent years. The silver-lead ores of Park City and Bingham have been the principal source. To these must be added the mixed ores of the Tintic district. From foreign ore and bullion, only 43,029 tons of lead was refined in the United States last year. This compares with 94,984 tons in 1911; the bulk of it coming from Mexico. The production of lead from domestic ores last year reached the total of 537,012 tons, comparing with 389,211 tons in 1910, a gradual growth. The American Smelting & Refining Co., it should be recalled, produces about 50% of the country's total output of lead. Next to the United States, the important lead-producing countries of the world are Spain and Australia.

DISCUSSION this week starts with a reminiscence from Mr. R. C. Canby, who recounts an unsuccessful effort to use cyanidation two years before the MacArthur-Forrest process was made known. Mr. Canby was one of the principal experts in the Minerals Separation-Miami case; hence his last remark is apropos. Our friend Mr. F. H. Mason contributes some notes on the tempering of drill-steel, dealing more particularly with the physics of steel as elucidated by Osmond, and indicating the part played by quenching. From Chile we have a letter signed by Mr. Mark R. Lamb, the representative, at Santiago, of an important machinery manufacturer. He describes a personal experience in the re-torting of quicksilver, with due consideration for the possible use of the flotation process. Mr. C. O'Brien, an experienced mill-man, lately at Kirkland Lake, breaks a lance with a recent contributor, Mr. Peckham, in regard to a special phase of cyanidation. His argument is that the continuous counter-current-decantation system, which he mercifully abbreviates to 'C. C. D.', does not lose efficiency by addition of high-grade ore, and that any failure to obtain the best results at Comacaran was due to an imperfect flow-sheet. Mr. H. E. Nicholls writes from London to approve Mr. Corey C. Brayton's recent article on a method of drilling alluvium and draws attention to an earlier article by himself on the same subject. Finally, Mr. Edgar Hall, one of our best friends in Australia, contributes bits of information that will be appreciated by our readers as coming from a man of varied experience.

A Delicate Subject

We note that the *Financial News*, of London, and the *Engineering & Mining Journal*, of New York, have got into a controversy on the subject of 'Americanizing British Mines,' referring thereby to the employment of American engineers by British companies. The subject has also engaged the attention of the *Mining Journal*, of London. These journalistic amenities were started by an intemperate and crudely phrased editorial in the *Financial News*, which is a low-grade paper not to be confused with the *Financial Times*, published at the same centre. The article in the *News* was followed by a number of letters showing much prejudice, and, we think, a regrettably provincial attitude. Some of the feeling that found vent in this ill-tempered outburst is the product of the War. At this time of great conflict, when half the world is under arms, the individual becomes touchy, if not belligerent, on international affairs. Civilization has become a 'rough-house.' Our most cherished beliefs and our dearest sentiments are being wounded during this terrible turmoil; we are on edge; even the best of friends wax warm over the issues at stake. No wonder then that the politenesses of life are in danger and we say things that in quieter normal days would surprise us. The controversy to which we refer is a sign of the times. Our own attitude in the matter will be readily surmised by our readers. In professional matters we are Mercurio, having no sympathy with either the Capulets or the Montagues that attempt to stir jealousy or ill feeling among English-speaking members of a broad-gauge profession. The American engineer employed by British companies has been selected on account of his ability; so long as he, in turn, selects his assistants and subordinates for the same reason, not on account of the place of their origin, he does what is eminently fit and proper. When, however, a junior is picked, not on account of fitness for the work in hand, but because he is a fellow-countryman, a brother-in-law, or a Baptist, the senior is not dealing fairly with his employer, whether that employer be a board of directors or the shareholders in a company. This error has been committed, and usually it has brought its logical punishment in the loss of confidence and the lowering of efficiency. We grant that some second-class Americans have gone to London, and have fared ill there; also a number of poor specimens went to South Africa, where they did not remain long; but only an ignorant man would deny the splendid service given to the British mining industry by such men as Gardner Williams, Hennen Jennings, George Webber, Frank L. Bosqui, W. L. Homgild, R. Gilman Brown, H. C. Hoover, W. J. Loring, and R. M. Raymond. We agree with our contemporary in New York that if the arts of mining and metallurgy, as applied to Great Britain's overseas dominions and her investments elsewhere, be unsatisfactory, it arises largely from the failure to appreciate the fact that the British empire was extended in the footsteps of the mineral explorer and that British trade followed, not the flag, but the

pick. Mining education also has received no such support as it deserves at the metropolis of an empire the development of which was based largely on the exploitation of mineral wealth. The Royal School of Mines, thanks to the help, among others, of an American, Mr. Hennen Jennings, has been saved from extinction, it is true, but it is absurd to consider its present status as satisfactory or its endowment as adequate for the one central mining college of a people whose flag flies over such mineral regions as Australia, South Africa, and India. Fortunately, Canada has taken care of herself in this regard. So that if this controversy is remembered, we hope that it will be to emphasize the fact that the mining industry needs efficient men, and will get them wherever it can, particularly from among those speaking the language of its Anglo-American operators and sharing with them the great traditions of fair play, honorable sport, and good government.

The Mexican Crisis

A state of war exists between the United States and Mexico, but at the time of this writing the fact had not yet been recognized officially. When, on June 17, the President called the State militia to duty on the Mexican border and followed this step by the publication, on June 20, of a note to the *de facto* government of Mexico, it was assumed that at last the policy of watchful waiting had been found unavailing; that a policy of *mañana* had given place to one of *hoy*. The public generally supposed that military intervention, as a preliminary to restoring order in Mexico, was assured and that the six years of Mexican misrule was to end in measures similar to the ones found effective in Cuba and the Philippine islands. Those who had property interests in Mexico may have been pardoned for supposing that better days were in store for them. But on June 22 Secretary Lansing sent a memorandum to the diplomatic representatives of the Central and South American republics in which he stated that the object of the United States government was "not intervention in Mexican affairs * * * but the defence of American territory from further invasion by bands of armed Mexicans, protection of American citizens and property along the boundary from outrages committed by such bandits, and the prevention of future depredations by force of arms against the marauders infesting this region and against a government which is encouraging and aiding them in their activities." We quote at length because this statement is one likely to have been overlooked or subordinated to the diplomatic note published two days earlier. No reference is made by Mr. Lansing to Americans or American property in the interior of Mexico; he mentions only such as were suffering from the banditry along the border. However, while the statement begins by disclaiming intervention, it ends in the promise of using the force of arms "against a government which is encouraging and aiding" such activities. This pointed directly at Señor Venustiano Carranza and his associates; and

as these gentlemen constitute the *de facto* government of Mexico, recognized as such by the United States, it gave warrant for the belief that war between the United States and Mexico would ensue, if the unsavory condition of affairs was allowed to persist. The truth concerning the Carranza government's attitude toward the brigands, of whom Villa was only one, and the attitude of that government toward American life and property, whether within Mexico or on the border, is made perfectly clear in the note of June 20. Indeed, that note indicates what bad faith Carranza has shown to the United States, the government of which stretched a point in recognizing him, in the hope that the recognition would strengthen his hands in the work of pacification. It shows that the effort made by General John J. Pershing's expedition to catch Villa and his followers received no assistance from the Mexican local or federal authorities, that other notorious bandits have holmobbled with Carranza's officers, and that the Mexican government has taken no steps to prevent repetitions of the Brownsville and Columbus raids. One weak point is the evidence that the punitive expedition was not sanctioned by Carranza, although on this the note is not clear, for in one place it is said that the expedition crossed the border under "the repudiated agreement of March 10-13" and in another place "it is admitted that American troops have crossed the international boundary in hot pursuit of the Columbus raiders and without notice to or the consent of your government." Again, the note certifies to the fact that the victims of the Santa Ysabel massacre carried safe-conducts issued by the local authorities. In that horrible affair, as in the Columbus raid, the Carranza officials took no steps whatever to obstruct Villa in the perpetration of crime. Then came General Jacinto B. Trevino's order, subsequently endorsed by General Alvaro Obregon, the Mexican Secretary of War, forbidding General Pershing to make any movement of troops except northward, that is, a retirement. General Pershing ignored this order; in consequence, on June 21, troops C and H of the Tenth (negro) cavalry came in conflict with a commando under General Felix Gomez, under circumstances not yet clearly disclosed, but with the result that several were killed on both sides and 17 American troopers were made prisoner. Thereupon, on June 24, the Mexican government coolly informed the American government that the attack at Carrizal was due to a disregard of Trevino's order to Pershing. To this our government replied by demanding "the immediate release of the prisoners taken in the encounter at Carrizal," with a peremptory request for an early statement as to the course of action the Mexican government proposed to take. Obviously, Mr. Wilson is loath to commit this country to war; equally obvious is the fact that Señor Carranza shrinks from starting definite hostilities; but it looks as if Villa's expectation would be fulfilled and his depredations force Carranza either to war with the United States or out of office. That is the position today. The logic of events will prove too strong for either side. At this time of writing it appears to us that war, followed by military

occupation and political intervention, in order to ensure orderly government, is inevitable.

Mining Education

This is a subject often discussed in the MINING AND SCIENTIFIC PRESS, and we offer no apology therefor. Education is one of the fundamental problems of the orderly way of living called civilization and it must interest every man, both as a son and a father. In this issue we publish a thoughtful article by Mr. F. Lynwood Garrison, himself the product of a generous culture and a wide experience. He comments upon the fact that an art is best taught in the place where it flourishes, while mining schools are usually situated far from the mining regions. As to that, it is natural that schools should flourish near centres of population. Freiberg gave this country more good analysts and chemists than mining engineers. It is the old question, whether it is better to bring the fuel to the mine or transport the ore to the fuel-supply. Colleges and schools need the support of a large population even more than the stimulation of an environment congenial to a particular branch of study. The reason why the small college in a small Western town spoils good ranchmen in the vain effort to make mining engineers is that it cannot give its students such a range of instruction as is within the scope of a central university. We agree with Mr. Garrison that a mining engineer requires a broad education; he needs all the education he can get in order to cope with the wide variety of men and conditions he has to face during his professional career. Indeed, it is a career to test character. Next, Mr. Garrison refers to the part that the engineer plays in the life of the community. He is a 'super,' instead of a principal actor. The profession will never reach its proper status until the members of it recognize their duties as citizens and demand a larger voice in community affairs. Most of us think that the lawyer plays too great a part and too many of them. He does so not only because his occupation gives him practice in public speaking and writing, but because his cultural training is such as to fit him for leadership in politics and government. The broad or cultural education for which Mr. Garrison pleads as a preparation for the mining profession is exactly the training that makes not only a capable engineer but a useful citizen. That should be the aim of a democracy or any other enlightened method of government. Lacking a general preparation for life, trained to be a specialist, prepared to pursue the elusive shekel, the mining engineer is likely to find his opportunities circumscribed. To practise as a specialist he must be where his specialty is in demand; to pursue the shekel successfully he must have a modicum of *minas*; for money makes money. Not many engineers are engaged in the particular branch of science for which they originally made some special preparation; most of us did the work that was first offered, and found our aptitudes after a good deal of 'knocking about' amid the fortuities of circumstance.



DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Discovery of Cyanidation

The Editor:

Sir—I have read with interest Mr. John S. MacArthur's article on this subject in your issue of June 10. It is, however, not the original discovery or use of cyanide as a solvent of gold and silver from ores that Mr. MacArthur describes. F. M. Endlich and Nicholas Muhlenberg filed a caveat in the U. S. Patent Office for a process utilizing the solvent action of potassium cyanide to extract by leaching gold and silver from their ores. Dr. Endlich was the general manager of the Sierra Grande, and associated mines, at Lake Valley, New Mexico.

In 1885 I went to Lake Valley to witness a trial-run of the Russell hyposulphite process in the interest of the directors of those mining companies. E. H. Russell was himself in charge of the Russell process plant, which had been built as an annex to the Boss continuous process pan-amalgamation mill. The extraction by the Russell process upon the 20-mesh ore was only about 72%. I was, therefore, persuaded to try Endlich's cyanide process. The cost of the cyanide, however, as compared with that of the "hypos" was such, and the improvement in extraction, if any, so slight, upon the 20-mesh ore, that Endlich's cyanide process was not substituted for the Russell process. This was before the days of fine grinding.

This trial of the Endlich and Muhlenberg process that I made in the Russell-process hyposulphite-leaching plant of the Sierra Grande company at Lake Valley, New Mexico, some two years prior to the experiments referred to in Mr. MacArthur's article, I believe to have been the first application of cyanidation.

I have always considered, however, that it was the very two things which Mr. MacArthur rather minimizes in his article that actually made the cyanide process economically possible; these were the effectiveness of the dilute solutions and the precipitation by zinc. I agree, however, most fully with Mr. MacArthur when he says: "Cyanide does this (dissolves gold from ores and holds it in solution) and so far as I know is the only solvent that can do it. This is the real essence of the invention—the matter of weak or strong solutions follows as a matter of chemical (and commercial) economies."

Such an expression from Mr. MacArthur is extremely apropos in the present flotation litigation, in which it is contended, against the pretensions of the patentees of the minute quantity of "oil," that it is the flotation by

use of such reagents that is the "real essence" of the process the matter of more or less of the reagent being "a matter of chemical and commercial economies."

R. C. CANBY.

Wallingford, Conn., June 15.

Tempering Drill-Steel

The Editor:

Sir—In your issue of May 27, you publish a drill-manufacturer's recipe of 7 lb. blue vitriol and 4 lb. sal-ammoniac dissolved in 15 gallons of soft water for tempering drill-steel. From the earliest days of steel to the present time, blacksmiths have had their pet recipes for tempering steel, and often have guarded the secrecy of them with a persistency worthy of a better cause. In the 16th century some very quaint recipes were published, as, for instance:* "Take the blood of a man XXX years of age, and of a sanguine complexion, being of a merry nature and pleasant, and quench the steel in it." I don't say these recipes have no merit; they have, but, as what merit they possess lies in the varying thermal conductivities of the liquids, the end may be attained by less lung-irritating or typhoid-inducing fluids than those mentioned above.

Osmond, the French metallurgist, has shown that iron cools from a bright-red heat at an almost even rate until it reaches a temperature of 858° C., when the cooling is arrested, and it takes 26 seconds for the temperature to drop through an interval that had previously taken and subsequently took only 6 seconds. With low-carbon steel there are two points of arrest, at about 720° and 650°, respectively, while with high-carbon steel these two points seem to be merged into one, and there is a long period of rest amounting in the case of 1.25% carbon steel to 76 seconds while the temperature dropped from 685° to 665°, while previously it had fallen through a like number of degrees in 12 seconds. Steels containing 20% manganese or 10% tungsten, on the other hand, were found to cool at a uniform rate without any marked period of arrest. Osmond found that if ordinary steel was heated and quenched rapidly before it reached this period of arrest, or the critical temperature, as he called it, it was hard, but if quenched after the critical temperature it was soft. High manganese and tungsten steels, which showed no critical temperature, are hard when cold whether they are quenched or allowed to cool slowly.

*English translation of "Rechter Gebrauch d. Alchemie!"

From these experiments Osmond argued that at the critical temperature there is a re-arrangement of the molecules, and in the case of steel there is a re-arrangement of both iron and carbon molecules, and that while before the critical temperature the carbon is dissolved in the iron, after that point it exists as a carbide of iron. The point, then, in hardening steel, is to cool the metal before the molecular change takes place, and while the carbon is dissolved in, and gives hardness to, the steel. Steels that pass rapidly from the one state to the other require a quenching fluid of high thermal conductivity, in order that the molecular change shall not take place during the process of quenching. In the tempering, or 'letting down,' as the blacksmiths often call it, it is often desirable that the quenching operation shall be prolonged, so that the carbon may be judiciously mixed in the two forms, and in this case a quenching fluid of low thermal conductivity is desirable.

San Diego, June 7.

Flotation for Cinnabar

The Editor:

Sir—The communication from Mr. E. M. Hamilton on this subject in your issue of April 15 makes it seem probable that our experiments at Punitaqui (Chile) will be of interest.

We are retorting quicksilver ores containing from 0.4% up, in retorts varying from 12 to 24 in. diameter. The recovery on the low-grade material is much lower than on the ore above 3%. The ores contain the quicksilver in four distinct forms: cinnabar is the most important; a red powder supposed to be an oxide is next in importance, followed by native quicksilver and a tetrahedrite containing 10% quicksilver in the pure mineral.

When the price of quicksilver drops to \$30 our problem will be to choose between a McDougall furnace and flotation. Flotation gives a high extraction. The oxidized ore simply cannot be wetted, and the cinnabar is little better. The tetrahedrite would concentrate well on tables and also gives excellent results with oil. The only tests that show a loss of native quicksilver with flotation are on minerals very poor in sulphides. The ore is mainly quartz and a soft gangue.

So far, I have decided that retorting is much the cheaper treatment, even assuming a perfect extraction by flotation. Even in the present slow and fuel-wasting manner, the retorting is extremely cheap—much cheaper than the crushing. The cinnabar sometimes occurs massive or in 20 mesh crystals, but 90% of it is in the form of finely disseminated particles in the quartz. This would mean fine grinding, which would cost more than roasting, and the plant would be much more expensive. At present we are roasting three tons with a ton of wood worth \$3. With a McDougall we could roast 10 tons with the same fuel. This does not mean, of course, that we shall discontinue our tests, in the hope of being able to

treat the big waste-dumps in the most profitable way.

Our greatest loss at present is in the vapor that cannot be disentangled from the ore, after the major portion has been dragged out by the water-vapor. In the large retorts containing 600 lb. of ore with a content of 24 lb. of quicksilver, it will be easily seen that half the metal can remain in the interstices of the ore, whatever the temperature. When coarse ore is being treated, it is not difficult to make this vapor move forward into the condensers by squirting about a gallon of water upon the red-hot ore, but with fine, this plan does not give the desired result.

MARK R. LAMB.

Santiago, Chile, May 16.

Cyanidation at the Comacaran Mine, Salvador

The Editor:

Sir—In studying the article by Mr. A. B. Peckham appearing in your issue of April 29, one cannot help but note the difference in practice between the continuous counter-current decantation process as used there and in such localities as Porcupine, where it is recognized as a success.

The flow-sheet presents something unusual in the re-grinding closed circuit. Why the crushed ore from the stamps is sent to a Dorr duplex classifier, the overflow going to thickeners, the heads to a simplex classifier, by-passing the tube-mills, is difficult to understand. The flow-sheet shows nothing entering the tubes but something coming out. This must be a mistake in the diagram. However, more information is gleaned by reading under the heading 'Tube-milling and Classification.' A suggestion will not be amiss. Even a casual analysis of the ore and screen tests would make the article of greater value to metallurgists.

Looking over the 'Slime treatment,' five agitators are in use, two mechanical-air and three Pachucas. The size of these agitators is important but it is not mentioned. Experience all over the world proves that intermittent or charge agitation is not any better, if as good as continuous agitation. The first cost of the latter, and certainly the operation, is less. The agitation would be disclosed by analyses and screen-tests, seeing that a 55c. loss of 'insoluble' metal is acknowledged.

'Continuous Decantation.' To one accustomed to the simple and efficient manner of regulating the passage of the pulp and the counter-current, so that it becomes almost automatic, the reason for juggling the solutions is not readily apparent. In the 'C. C. D.' process, the distinction between values of the dry slime and solution are of paramount importance, especially at the dewatering end.

'The pulp from the Pachucas, which contains about \$3.50 together with the clear overflow of battery-solution from thickener No. 1, which contains \$1, goes to thickener No. 4. The clear overflow from No. 4 to the rich-solution tank, which assays about \$1.75 per ton.'

"The pulp from the Pachucas, which assays about \$3.50." Is this value in dry slime alone? This is quoted under 'Slime treatment' as 25% or three to one. "The clear overflow of battery-solution contains \$1." Exception must be taken to this misnomer. It is not battery-solution, but the overflow from the closed grinding-circuit, as the flow-sheet shows the Dorr duplex classifier to be the only outlet to thickener No. 1. Therefore \$1 is the value of extraction, dissolved value, in the closed grinding-circuit, consisting of stamps, two classifiers, and five tubes. This seems strange. Practice today is considered poor if it does not dissolve at least 50%.

Precipitation of solution, value \$1.75, cannot be said to be the best practice, when so much richer solution can be precipitated at the same cost, greatly curtailing the work in the refinery.

The flow-sheet does not show the overflow of battery solution from thickener No. 1 going directly, as stated, to thickener No. 4. It passes through settler *D*. What function this performs is not stated.

Coming to 'Tailing.' One notes a 10c. loss as dissolved value. This is certainly good work; credit must be given and taken. The 'insoluble' metal loss is 55c. In the tables, under 'Solution Assays,' 'Tailing thickener 7,' the word 'undissolved' is used. There is a vast difference between 'undissolved' and 'insoluble,' in metallurgy.

The rakes of the thickeners are said to have caused trouble by sticking. No doubt, some of us have had the great pleasure of emptying and cleaning out thickeners. The chief and really only cause of that is abuse. All sizes of thickeners, like all machinery, are calculated to do so much work, and no more. When they are overloaded, like the mule, they buck and stick, or the central shaft turns into a corkscrew. In this case the Frenier pump, a pulsator pump, might have been the trouble. In time, a large amount of hard pulp is likely to have accumulated on the bottom of the tank. The raising of the rakes gave a little more grade.

A difference of opinion arises concerning the disadvantages mentioned. No necessity exists for precipitating a large amount of low-grade solution. The reverse is more nearly true. For obvious reasons the highest grade of precipitate is desired, principally to save zinc and refinery work. The precipitation will regulate the barren solution. All that is really desired is enough for the counter-current. The water-wash will balance the amount of moisture sent to the dump. It is not obvious why barren solution is fed to thickeners No. 5 and 6; one should be sufficient. A paramount feature of the decantation end is a steady counter-current and a general equilibrium. But under 'Sand treatment,' barren solution is used for 'baths.' This is hardly fair to the 'C. C. D.' This explains the large amount of barren solution. The process is only meant to take care of itself, not two processes. (2). The impracticability of the process with an ore that resists settling. This is vague. An ore that resists settling may still settle sufficiently to permit good work. An ore that will not settle has few

charms for the 'C. C. D.' process, as should have been considered in the beginning. The Dorr people are frank in this matter. They make all their calculations on 50% moisture. So this cannot, again, be called a disadvantage. (3). The C. C. D. process is not thrown out of adjustment, any more than any other process, by a sudden rush of rich ore. Of course, a higher tailing may result. This is not a metallurgical difficulty, but a mining difficulty. If the mill-heads are doubled it is not necessary to double the amount of barren solution, nor use more water, nor is it sound metallurgy to say the tailing-loss will double. What is the grinding-circuit doing at this time? Is it dying of *ennui* or a devotee of *mañana*? (4). A large amount of water is not used in the C. C. D. process, only just enough to make up for the amount of moisture sent to the dump. The process is continuous and therefore re-uses all the water, solution, etc. But, if as said, water is scarce, precautions should be taken at the beginning, and something like an Oliver filter installed to save as much moisture as possible.

Without exaggeration, it can be said, that the continuous counter-current decantation process has come into the field of metallurgy with less trouble and more practicability than any other process. It is just as amenable to the treatment of high-grade as of low-grade ores, both gold and silver, and is being installed to treat highly complex ores. In the beginning the metallurgy and the plant should conform to the highest grade of ore in the mine, then it is easy to take care of the lower grades of ore. Its flexibility is unequaled by any process as the four different types above. It has redeemed decantation.

Reviewing the mechanical side of the plant: With the large experience before us today, why install stamps? Let us make a short comparison with a ball-mill. The Hardinge conical ball-mill is in general use. A 6-ft. Hardinge will do the work of 15 stamps; it is cheaper in first cost, mill to mill; takes up considerably less space, consequently less building; less weight; less foundation; uses less power; crushes ore for less per ton than stamps; not half the trouble and work for the millmen; is not any more difficult to transport on mule-back, if as troublesome, when you figure heavy stems; the putting together is not more difficult than batteries; any kind of crushing can be done to suit conditions; amalgamation can be performed, if desired, with less trouble and space. So, really, what advantage do stamps have today?

The use of Frenier pumps, or pulsators, is new in the C. C. D. and it is doubtful if they can be recommended. No one would use them after having tried the cheap easy running diaphragm pump.

The many experiments with tube-mills in South Africa proved that the 20-ft. mill was not any better than the 16-ft. mill, if as good. Neither crushing nor re-grinding takes place in the last four feet, so of what use is it? Any U. S. machinery is just as good as Krupp's.

C. O'BRIEN.

Berkeley, June 9.

Prospecting Before Dredging

The Editor:

Sir—My attention has been drawn to the article on this subject appearing in your issue of April 29. The author refers to a new method of drilling by driving pipes, as used extensively by him. The method is one which was adopted by me in the Malay States as long ago as 1903 and was the subject of a short paper read before the Institution of Mining and Metallurgy, London, and incorporated in the transactions of 1904-1905.

I have employed this system with equal success in northern Nigeria; given suitable conditions, it is without doubt not only the cheapest but also one of the most reliable methods of testing alluvial deposits. My own experience is fully borne out by the figures given by Mr. Brayton in his very interesting article.

London, June 2.

H. E. NICHOLLS.

Useful Notes

The Editor:

Sir—In one of your recent issues you refer, as you have often done previously, to the waste of mining information owing to so much experience passing unrecorded. May I contribute a little of my experience in some matters touched upon in various articles in your issues of January and February, which have just reached me?

(1) American Machinery Exports. Among the important points necessary for exporters, I think that of insurance has been omitted. Next to having the articles properly packed, their insurance during transit is of the most importance to the buyer. It is not enough to insure the goods for the amount of the invoice; sufficient must be added to cover freight and other outgoings that the purchaser must pay, and often in advance. Insurance companies recognize this, and it is customary to increase cost and charges by 10% to cover further possible losses to the purchaser (through delays or changes of price incidental to duplication of the article lost). This does not appear to be understood by some American manufacturers.

Some years ago I bought a machine direct from a large American firm, one that advertises largely in all the technical papers and inundates members of technical societies with its literature. I instructed them to pay freight and insurance, and our London bankers paid them cash on shipment. The vessel soon after went to the bottom with our machine on board. When we went to collect the insurance we discovered that the policy covered only the cost of the machine at the maker's works. Result: we lost freight and other charges amounting to \$150, and resolved to buy nothing more from that firm, if we could help it.

(2) Prohibition. This village, of about 600 inhabitants and solely dependent on the mine, has no hotel or licensed house. For several years the land was held so that the owners' opposition was sufficient, later the ap-

plication for license was defeated by direct voting, under a local-option clause in the State Licensing Acts. The mine worked continuously from May 1893 to the outbreak of the War, a period of over 21 years. The depth attained is 500 ft. vertical; the orebodies are isolated lenses; the ground is heavy in general, and in places very bad. Only one fatality occurred during the 21 years: a fitter, sent below to repair a leaky pipe, looked down the shaft and was struck by a descending cage. Only one broken limb occurred: to a miner, attempting to light a cigarette when in a moving cage, whose projecting elbow struck a landing. No other accident, at mine or smelter, to any workman, could be called serious. No shift was ever lost owing to drunkenness, and no delay ever occurred at the furnaces owing to absence of men through drink. There were no St. Mondays. No other Australian mining town has such a record. We did not escape 'sly' grog-shops, but judging by our experience, the harm done by drinking on the sly is small compared with that of even one well-conducted open and publicly-licensed hotel.

(3) Early Ball-mills. At the Sunny Corner mine, in N. S. W., when I went there in 1887, there was a ball-mill procured, I believe, from San Francisco. It was then idle. I got it going and used it for crushing quartz for making silica bricks. It did excellent work.

(4) Nodulizing. At the same Sunny Corner mine, in 1888, I treated a large quantity of sulphide ore 'fines' in exactly the way described in your issue of February 12, as now practised at the Braden mine, only we did not call it 'nodulizing.' We used a revolving calciner, got about the same reduction in sulphur content, and the same red-hot nodules of varying size, and treated them very successfully in blast-furnaces, apparently just like the people at Braden. Again, at Silverspur we have a small sinter-plant for fine, which we used for some time, like that described at the Braden, only our boxes, though of the same width, and using similar grate-bars and down-draft, are much shorter. The results were the same and the sintered material worked well in the furnace.

EDGAR HALL.

Silverspur, Queensland, April 20.

THE Russian *ruble* is equal to \$0.5145673 United States currency. At the present time Russian exchange is quoted at \$0.3075, the decrease since 1913 being as follows: to 51.50c. in 1913, 51c. in the first part of 1914, 42c. in the second part, 29.75c. in 1915, and 29.31c. to June 13, 1916. Although the *ruble* has declined about 40% abroad, its purchasing power in Russia is more nearly holding its own, advances and decreases in prices of commodities being due chiefly to changes in supply and demand.

TUNGSTEN ORE (wolframite) concentrated at the Wasp No. 2 gold mine in South Dakota since early in 1916 totaled 1800 tons, averaging 1.08% tungstic tri-oxide (WO₃). The tailing assayed 0.13%, giving a recovery of 88%. Concentrate averaged 50 per cent.

Mining Education

By T. Lynwood Garrison

IT might naturally be supposed that the mining engineering profession would be largely recruited from boys who have grown up in communities associated in one way or another with the mining industry. While, of course, many such boys drift into it by opportunity or desire, it is a notable fact that very many of our distinguished mining engineers of today were born and reared in great cities remote from everything appertaining to mines, minerals, or geology. Similarly some, if not a majority, of our great mining schools have had their origin and now flourish in large centres of industry and population in no way directly related or connected with the mining industry.

A student in every other branch of engineering may without difficulty find in all large cities practical applications of most of the technical subjects with which he must familiarize himself, but the mining student must needs go far afield, often to considerable expense, and seldom has the opportunity of seeing what he learns in the class-room put into immediate practical use. This is an unfortunate condition and a serious handicap to the students, for an art is best taught in the atmosphere and environment in which it flourishes. Probably the most ideal and certainly the most famous mining school in the world is that at Freiberg in Saxony, situated on the northern flank of the Erzgebirge, a mountainous district famous for its mines since the Middle Ages. Indeed the old Saxon Mining Academy may justly claim to have been the mother and model of our American mining schools; the writings of its professors, such as Plattner, Von Cotta, Rittenger, Beck, and Stelzner were and still are among the classics of the profession. And although its glories have departed with the closing-down of most of the neighboring mines and the rise of institutions better qualified to teach the Anglo-Saxon, the Royal Saxon Mining Academy in my student days was a name to conjure with and offered its students an excellent technical training both theoretical and practical. Like most German universities, the social atmosphere of the place, however, was coarse and degenerate, sometimes demoralizing and often disgusting to American and English boys reared in refined and cultured homes where the laws of God and the moral precepts of man had been taught and respected.

There has doubtless been a great advance in the efficiency of our American mining schools in the last twenty years, but at the same time there seems to have been a needless duplication of effort that has tended to crowd a profession already overstocked with varying degrees of talent. Some of our Western universities have established mining schools, and mining schools as such have been started in Western towns simply because they hap-

pen to be relatively near mining districts. I once heard a mine manager say that as far as he could see the practical result of most of these schools was to spoil good ranchmen and make mighty poor engineers. This brings me back to my original thesis, that a mining engineer should above all else be a broadly educated man and that such a foundation may be best obtained as the result of a general university training. I doubt if any profession subjects its members to tests of character so severe and so prolonged as does that of the mining engineer. Consider for a moment how often he is placed in places remote from restraining influences, where he cannot seek advice of his elders or benefit from the stimulating moral control of home and family. In the absence of these checks a man must fall back upon his own cultural and mental resources, his books, his pen, and a love of Nature, into which the educated man sees so much deeper than one who has not been taught. A mining engineer often finds himself in situations so absolutely detached and foreign to the life he has been accustomed to, that it becomes a serious test of character if he has no diversions save his employment and the often frivolous pastimes of his companions. It cannot be disputed that a too complete absorption in one's work is bad both for the man and the job, hence it is highly important that the mind for short periods should be completely detached and interested in something wholly unconnected with the engineer's daily occupation. Under such conditions the broadly educated man has a great advantage over one who knows the technicalities of his work and little more; in lonely remote mining camps it is the idle hours that are the real menace to both body and soul. In this connection it is well to remember that on the last analysis it is the man, not his tools, that makes civilization, and the character of it will be either brutal or ethical according to the spirit he infuses into it.

There is another subject relating to an engineer's education that has received little or no attention, that is, his fitness and the indisputable importance of his taking an active part in the public life of the nation. We live today in a mechanical age, yet it is the rarest thing to find men who have had engineering educations in the supposedly deliberative bodies that make our laws or in the executive positions and offices that administer them. No country in the world affords such abundant opportunity for higher education as the United States and the least its recipients can do is to make some return in public service. During our Civil War the military officers on both sides of that unfortunate contest were largely recruited from the professions, chiefly the law; for in those days engineering had hardly reached the dignity of that designation. Yet today, although we are

living in an engineering age, the engineer as a citizen has no more influence or voice in public affairs than fifty years ago. This is all wrong, for it is a serious blunder that the laws now governing us should be framed and administered by men wholly unfamiliar with engineering in any of its branches. That men are competent to frame laws simply because they are lawyers is absurd, for law is or should be based on common-sense and a thorough understanding of the physical conditions affecting the different phases of human life and endeavor that it is intended to regulate. In the present War the British are drawing heavily upon the engineering professions for their army officers and the response has been gallant and unselfish. Now, conditions of life in England and the United States are almost precisely alike as to fundamentals and under similar circumstances we shall blunder, expend lives, treasure, and time just as they are doing, so the British are not only fighting our battles for us against the common enemy of liberty and all mankind, but they are giving us a vivid object-lesson as to how we shall err and behave when our turn comes. Anticipating that time, we are now engaged in a campaign of 'preparedness'; it is a most welcome sign of national sanity and it is to be fervently hoped it will continue unabated until something substantial is accomplished. The plan suggested by President Wilson in calling for the co-operation of our national engineering societies is a wise one, for they are likely to become the very backbone of any sane common-sense scheme of defense. And I think it will be found that the engineers who will become the most efficient leaders are those having broad educations and tolerant sympathies.

As to the over-crowding of the engineering professions in general and that of mining in particular, I would venture to say a few words. It is obvious, it seems to me, that if the engineer is to live a narrow life and confine himself strictly to the technical phases of his craft, the field is certain to be restricted and over-supplied. My notion is that simply because a man has had an engineering education and training is no reason why he should confine his activities exclusively to that class of work. The mere fact that a youth has had such an education ought to make him a better business man, a more efficient public servant, and a better all-around citizen than if he had not had it. It is a hard rough road to the top in any narrow strictly professional career, and one will notice if he looks carefully about him that today many, if not most, of our leading engineers are also good business men. It is certainly no disgrace to make a business of one's profession, indeed I would go further and say a man is a fool who neglects to do so unless he is on a salary and employed in strictly technical work having little or nothing to do with the commercial end of the organization with which he is connected. I think I have said enough to show that a professional man cannot be too broadly educated, but there is a great danger in sending out into the engineering professions men who are simply skilled artisans, whose hands are trained but not their heads; such men are useful for what they can

make in the same sense a brick-machine is valuable for the bricks it produces, but as its capabilities are strictly limited to that product, nothing more may be expected of it. A man, on the contrary is a living, growing, developing entity whose capabilities may often be unsuspected even by himself, until opportunity or force of circumstance compels him to do things he never anticipated doing. It is to the glory of our race that we so often do them well, and one may be thankful to live under a system of culture that develops the individual and in a country that affords abundant opportunity for personal initiative. We hear much said against soulless corporations, and indeed this indictment has often been justified, but it must be remembered that without the unity of individual effort in the form of corporations, there are a great many enterprises that could not be carried out; a corporation is simply a form of team-work in which a number of individuals are pursuing a common purpose in a co-ordinated effort. As our mineral resources become more and more depleted the individual has an increasingly difficult task in competing with corporations having great resources in both brains and money. As ores become leaner it is necessary to handle a larger and larger volume in order to make profit; a logical corollary to this is the increasing equipment and a pay-roll; hence the obvious and consistent line of least resistance is for the individuals to combine into an impersonal corporation. Of course, the tendencies of corporations is to stultify individual initiative, which is to be deplored, but it is hard to see how this may be avoided, although no doubt there are some corporations that give considerable latitude to their employees and due credit to their ability and genius. I believe a young man fresh from college should seek employment with a corporation whose system is well matured, and that has a sound traditional policy, even though the pay may be smaller than those organizations which appear to have no policy at all or treat their employees solely as parts of the machine designed for the purpose of making money. Men want money because they must live, but there is a subtle, though nevertheless distinct difference, between the attitude of mind which regards money solely as an end in itself, and that point of view which considers the wages of labor as the necessary complement to decent living. In other words, one cannot make a genuine success of life and disregard the human element in his daily work. Our system of culture was never intended to make machines of human beings, and we shall fight to the limit to resist anything of the kind.

COKE PRODUCTION of the United States in 1915 amounted to 41,581,150 tons, an increase of 20%. Of the total, 34% was by-product and 66% beehive-oven material, there being 5481 and 49,540 ovens worked, respectively. Pennsylvania made 25,622,862 tons of coke, followed by 3,071,811 tons in Alabama and 2,768,099 tons in Indiana.

TIN is being produced at Perth Amboy, in the A. S. & R. smelter, at the rate of 250 tons of electrolytic metal per month.

Specific Gravity Method for Tungsten Analysis

By J. J. Runner

It is probably true that in the great majority of tungsten ores, the gangue is composed dominantly of quartz. As a consequence, it would seem that the specific gravity of the gangue is a more or less constant factor. The ore-minerals of tungsten are, furthermore, usually confined to one of the wolframite series,* or to scheelite, the specific gravity of which is easy to determine. It is apparent, then, that if we know the specific gravity of the ore-mineral and of the gangue, we can easily calculate the percentage of the former from the specific gravity of the ore, and from this the percentage of WO_3 , or tungstic acid, in the ore, from the percentage of WO_3 in the ore-mineral, by means of the formula:

$$\text{Sp. gr. } O = \frac{x \times \text{sp. gr. } M}{100} + \left(\text{sp. gr. } G \times \frac{100-x}{100} \right)$$

$$\text{or } x = \frac{100 \times (\text{sp. gr. } O - \text{sp. gr. } G)}{\text{Sp. gr. } M - \text{sp. gr. } G}$$

where $\frac{x}{100} = \%$ by volume of mineral in ore

Sp. gr. O = specific gravity of the ore

Sp. gr. M = specific gravity of the pure ore-mineral

Sp. gr. G = specific gravity of the gangue

$x \times \frac{\text{Sp. gr. } M}{\text{Sp. gr. } O} = \%$ by weight of mineral in ore (W)

$W \times \% WO_3 \text{ in ore-mineral} = \% WO_3 \text{ in ore}$

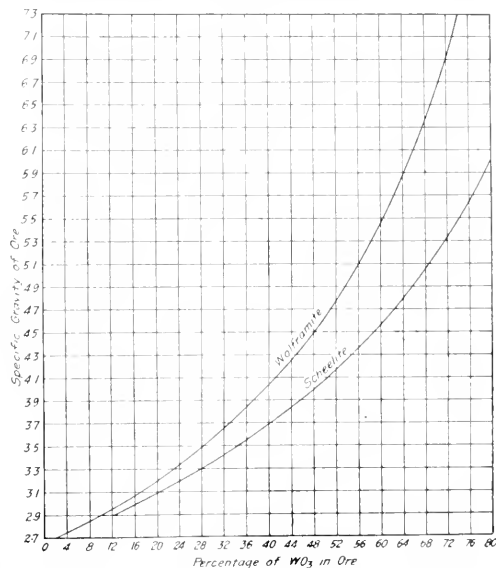
For logarithmic calculation,

$\log WO_3 = \log (\text{sp. gr. } O - \text{sp. gr. } G) - \log \text{sp. gr. } O + [\log \text{sp. gr. } M + \log \% WO_3 \text{ in mineral} - \log (\text{sp. gr. } M - \text{sp. gr. } G)]$.

To test the efficiency of such a method I have determined, with considerable care, the specific gravity of 18 ores of tungsten that were at the time available in the laboratory of the South Dakota State School of Mines, and computed their WO_3 content, assuming the specific gravity of the gangue to be 2.65, of the wolframite to be 7.35, of scheelite to be 6.0, and the WO_3 content of wolframite 74.58%, and in scheelite 80%, and compared these results with the WO_3 content obtained by chemical analysis. The results were satisfactory as will appear from a study of the accompanying table.

The value 2.65 is taken as the specific gravity of the gangue, for in all of the underground samples used, it

was evident that the gangue was predominantly quartz, in some cases with small amounts of sulphides, oxides, and silicates, on the whole, resulting in specific gravities differing little, though slightly higher than that of quartz. For the specific gravity of the wolframite series, Dana gives 7.2-7.5, and here the mean 7.35 was used. For scheelite Dana gives 5.9-6.1, hence 6 was taken. In wolframite it was found that 74.58% gave the smallest differences between calculated and determined WO_3



CURVES SHOWING RATIO OF SPECIFIC GRAVITY OF TUNGSTEN MINERALS TO RICHNESS IN TUNGSTIC ACID.

content; hence this value was adopted. It was not thought permissible to obtain a value for WO_3 in scheelite in a similar way from so few data, so that 80% was adopted.

The material for testing, in the case of nine of the ores, was taken from laboratory specimens, and the entire mass was pulverized. In the other eight tests, samples were taken from materials already ground, so that there was no selecting of ideal samples. The ores represent 11 distinct districts, and the value of the method lies particularly in the fact that such close agreements can be obtained from random ores representing so many occurrences. In some cases, however, it is doubtful whether the specimen used represented the average ore of its district, for example, the specimen of Cornish ore

*Throughout this article the name wolframite is used for the hübnerite-wolframite-ferberite series. The differences between the members are of scientific rather than of practical value, since the percentage of WO_3 and the specific gravity of each is nearly the same. Speaking of the series between the end members, hübnerite, $MnWO_4$, and ferberite, $FeWO_4$, Hess says: "For the mixtures between these end members the older term wolframite may properly be retained and this term may well serve as a general or field name for the members of the series which cannot be definitely identified."

over the ore just to the boiling-point, so as to expel air-bubbles, then cooling to the room temperature, exhausting under an air-pump in order to remove any remaining air, filling the pyknometer with freshly boiled distilled water, and finally weighing at the room temperature. This method is recommended wherever possible. All other results were obtained by a method so simple that it can be done in the ordinary small-town drug-store or any place where a balance of fair accuracy is to be found. The only apparatus necessary is a thin rather long, slender-necked, Florence flask of 25 cc. capacity, with a scratch around the neck near the top, to serve as a mark. Such a flask may be obtained from any company dealing in chemists' or assayers' supplies, at a cost of only a few cents. If coarsely ground ore (size of a pin-head) is used, the sample may vary somewhat from the true average for the ore, but for ordinary purposes it is better for there will be less difficulty in getting the ore to settle, and less trouble with bubbles. However, finely powdered ore can be used with success, if one exercises sufficient care and can wait long enough for it to settle.

Place a weighed amount of ore, about 5 grams (or 75 grains) in the flask, fill about half-way with water, heat until it just comes to the boiling-point, cool in a basin of water, then in several changes of water at room temperature, and finally fill to the scratch with water that has recently been boiled and cooled to the room temperature, taking care that no bubbles or particles of ore are floating on the surface, and that the inside of the flask-neck is dry so that the water will not climb up the side above the scratch. Care at this point is vital, for inaccuracies here will lead to serious error in the final result. When the level of the water is nearly to the scratch, it is best to complete the operation by dropping in the remaining water from a glass tube drawn fine at one end, for a large drop in excess results in a considerable percentage of error. The flask should be filled until the central and lower part of the water surface is on a line with the level of the scratch on the near and far side of the neck. Weigh the flask, with its ore and water, when it has come to the room temperature. It is also necessary to obtain the weight of the flask filled to the scratch with water. This should be determined by using freshly boiled water at the room temperature, and taking the same precautions as for the flask, with ore and water, mentioned above. If the flask is perfectly dry when operations are begun, it is better to obtain the weight of the ore, by first weighing the flask empty, then with ore, and subtracting. The specific gravity of the ore can now be calculated from the formula:

$$\text{Specific gravity} = \frac{O}{O + fw - fow}$$

where O = weight of the ore

fw = weight of flask with water

fow = weight of flask with ore and water

Having the specific gravity, the approximate WO_2 content can be found from the accompanying curves. First find along the vertical column the number corre-

sponding to the specific gravity of the ore calculated from the formula, then follow the line nearest this value to the right until it crosses the upper curve, if a wolframite ore, or until it crosses the lower curve, if a scheelite ore, and from this point go straight down and read the percentage of WO_2 in the ore on the base-line. For example, it will be seen from the curve that a specific gravity of 4.7 corresponds to a WO_2 content of 51.2%.

Mineral Production of the Black Hills

The Mine Inspector's report for 1915, covering this part of South Dakota, gives the following output:

Mine	Tons	Value of gold
Golden Reward	58,827	\$484,995
Homestake	1,573,822	6,446,191
Mogul	37,419	161,605
New Reliance	27,645	61,508
Trojan	79,903	276,188
Wasp No. 2	111,290	183,488
Placers		1,822
Miscellaneous	950	3,887
Total		\$7,619,684

The Homestake also produced 25 tons of tungsten ore worth \$31,331, and the Wasp No. 2, 187 tons valued at \$147,730.

THE COBALT DISTRICT is beginning to show signs of prosperity since the price of silver rose. Exploration is increasing and search for the high-grade little veins is stimulated. Reginald E. Hore, a geologist who has given particular attention to northern Ontario, says editorially in the *Canadian Mining Journal*, "the geological structure at Cobalt is such that one can reasonably expect to find silver on some claims that show no ore at surface. It is characteristic of many of the orebodies in the conglomerate of the Cobalt series that they lie close to the underlying Keewatin and pitch with the sloping contact. Where erosion has worn the conglomerate thin, the ore outcrops. In other places, however, the ore does not extend to the surface, and can only be discovered by underground exploration." This helps to explain the disappointment that occasionally comes when a company removes the surface soil or unwaters a lake, hoping to find outcrops of rich veins. These may be present but not outcropping. The structure suggests the reason for lack of depth of many of the orebodies, because they are close to the contact of the underlying Keewatin, in which the veins are apt to be barren. Mr. Hore calls attention to the importance of studying the faulting system at Cobalt, and indicates also the significance of the thick sheets of diabase that intrude the other rocks. "On the theory that the lower contact of the diabase is a promising horizon, development at considerable depth is to be undertaken at the Beaver and Teniskaming mines, where the early workings were in rocks overlying the diabase."

Mining Around Lovelock, Nevada

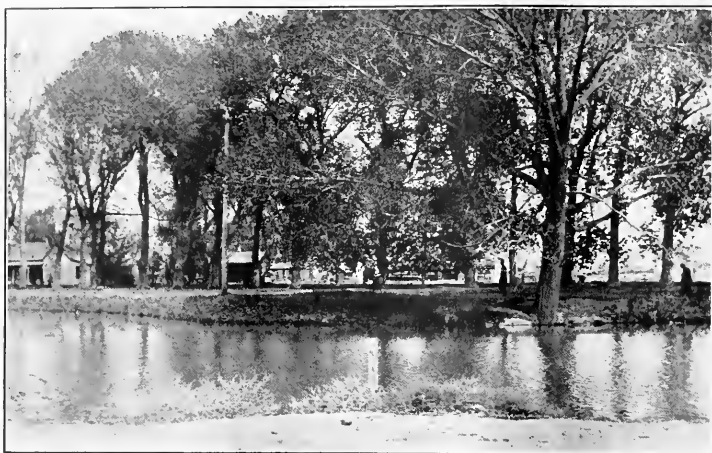
By P. B. McDonald

Nevada has the least people and the most mines of any State in the country. It has more square miles than inhabitants, and for the most part is rightly pictured as an arid waste. There are, however, a few places where conditions favor ranching, and where oases appear in the sage-brush desert. These are the more attractive if they can be used for a headquarters by miners and engineers. Since the coming of the automobile, 30 or 40 miles can be traveled with ease, to give the dust-covered mining man a change of atmosphere at week-ends or between trips. Such an oasis is the town of Lovelock in the north-western part of the State on the main line of the Southern Pacific Railroad, the centre of a prosperous cattle industry and of varied mining activities. By aid of water from the Humboldt river, the valley produces excellent alfalfa for feeding cattle and sheep, which are sent from a wide area in the West to be fattened for the San Francisco market. Lovelock is preferred for this purpose rather than California, because it has no rainy winter.

A two-hours automobile journey south-eastward from Lovelock brings the traveler to the much advertised Rochester silver district, and the same distance northward are the Seven Troughs gold mines. The Humboldt range has long been a famous producer of the precious metals; it was here that the old Queen of Sheba and De Soto mines of George Hearst were situated. Regarding the foundation of the Hearst fortune, a writer in the *Oreland Monthly* remarked recently, "Little did the old-timers dream, as they prodded their oxen to brackish water-holes with creaking loads of ore, that the wealth they carried would some day appear in screaming headlines." A number of prospects and small mines are scattered throughout the region. Some are being operated, others are idle, and still others alternate between these conditions. Besides Rochester and Seven Troughs, I may mention Mazama, Vernon, and American Canyon, all small mining camps. At Rochester a half-dozen silver mines are operating, notably the Rochester Mines, Rochester Merger, Nevada-Packard, and Lincoln Hill; and at Seven Troughs are several gold mines, the more important being the Seven

Troughs Coalition, Seven Troughs Mining Co., and Mazama Hills. Tungsten has been found west of Lovelock; several mines are now producing tungsten ores, and one or two concentrating-mills are being operated near Toy, along the edge of the Humboldt sink. South-east of Lovelock, about 60 miles, is Bernice, near which are the antimony mines described recently by Willard Mallory.*

The two principal mines with headquarters at Lovelock are the Rochester Mines Co. and the Seven Troughs



WATER IN NEVADA. A SCENE AT LOVELOCK.

Coalition Mining Co. The former, a silver mine working on wide veins of moderately rich ore, is the largest producer in the Rochester district; it has extensive workings well developed by adits, and a 10-stamp continuous-decantation cyanide-mill of a capacity of 120 tons per day; the company recently accomplished the payment of an indebtedness of \$200,000. The Coalition mine, in the Seven Troughs district, is a spectacular producer of high-grade but pockety gold ore; its output last year was \$335,736, of which \$180,382 was paid in dividends. A 10-stamp mill extracts the gold by amalgamation, the concentrate being shipped to the Selby smelter on San Francisco bay. A cyanide-plant was destroyed by a cloud-burst several years ago, when 10 lives were lost. The mine is 1650 ft. deep, and the vein has been much faulted. In one month, October 1915, over \$60,000 was produced, at the rate of \$2000 per day from a 10-stamp mill—a pleasant performance while it lasted!

*M. & S. P., April 15, 1916.

The Rochester mine was operated under a leasing system up to a year ago. This did not prove satisfactory; it became apparent that the lessees were working the 300-ft. blocks as separate mines without any regard for the future. Drifts in the various blocks were not on the same level. Accordingly, the Rochester Mines Co. purchased the three leases for \$40,000; also the adjacent Weaver claims were secured. The lessees had produced \$938,515, all from ore averaging over \$20 per ton. The company, operating its own mine, has produced in nine months \$433,606, part of which was from purchase of custom ore. The machinery has been centralized at the mouth of the lower or Friedman adit. The upper or transportation adit has been straightened, widened, and laid with 12-lb. rails. There are three productive veins; the stopes vary up to 15 or 18 ft. wide, and the ore runs as high as \$90 per ton, but most of it averages \$10 to \$30 per ton. The ore is hand-picked before being sent to the mill. The cost per ton of mining during the nine months to May 15, 1916, was \$3.35, of which underground tramping absorbed 30c., timbering 35c., ore sorting 9c., and surface tramping 13c. Explosives cost 22c., and power 23c. per ton. For the month of May, 1916, the total cost of mining was \$3.10 per ton, showing a slight reduction. At present two shifts are worked; the night shift drills and breaks the ore, the day shift loads, trams, and sorts it. By this arrangement everything is made ready for the drill operators so that they have a minimum of interruption and bother. Also the requirement for power is distributed to equalize the demand; this is helped further by doing the coarse crushing at the mill when no power is needed for drilling. Power is furnished to the mine and mill by the Nevada Valleys Power Co., which derives it from the Lahontan dam, a government irrigation project 85 miles distant. The power is bought at \$8 per horse-power per month.

The mill was started to operate in March, 1915. A feature of the practice is the grinding of 93% of the ore to 200-mesh. The mill was designed by G. W. Wood of the Dorr Co. It is a continuous counter-current decantation cyanide-plant, using Dorr thickeners without a filter. A complete description of the mill, written by Mr. Wood,[†] was published in this paper a year ago. The cost per ton of treatment in the mill during the year ending May 15 last was \$2.69, of which coarse crushing and sampling took 16c., stamping 33c., tube-milling 60c., thickening 7c., agitation 52c., decantation 17c., and precipitation 49c. The cost for power was 56c. per ton. For the month of May 1916, the total cost of milling per ton was \$2.14, showing an appreciable reduction. Adding to this the cost of mining, \$3.10, the total is \$5.24. Indirect expense, such as transportation, water-line, taxes, etc., was 89c. per ton, making the total of all expenses \$6.13 per ton. This figure seems high but the practical difficulties overcome have been considerable.

The president of the Seven Troughs Coalition Mining Co. and the Rochester Mines Co., is L. A. Friedman of

Lovelock. Mr. Friedman has persisted in operating the Coalition mine since the rush to the Seven Troughs district, which came as an aftermath of the Goldfield boom



THE ROCHESTER MINE; ENTRANCE TO THE TRANSPORTATION ADIT.

in 1907. The Coalition mine has had a hard row to hoe, in spite of its high-grade ore. Faults in the vein, the disastrous cloudburst, and internal disagreements among stockholders have interfered with regular production. It has been necessary to go deep for the ore, and at times it has required considerable faith to keep going. Later, Mr. Friedman secured control of the Rochester Mines Co. His management has been criticized at various times. He has run things in a vigorous way to get results, and has conducted a wide publicity campaign for making the stock known on the mining exchanges. As indicative of the internal differences that have arisen, I may mention the recent statement by Mr. Friedman to the stockholders concerning the previous management. He said: "How men can do what has been done in the affairs of your company and escape the penalty of the law is beyond my comprehension." In a general way it should be remembered that any energetic man with a definite policy makes enemies; and to achieve results, he must be allowed to manage a mine according to his understanding of conditions.

[†]M. & S. P., August 28, 1915.

The Theory of Flotation

By H. Hardy Smith

IT appears to me that the problem of elucidating the theory of flotation could be greatly simplified by formulating some definite line of attack; the first consideration in which should be to segregate the various physical forces with their attendant phenomena, and to attack each in turn.

It is quite possible, in fact, most probable, that some of the forces come into play in all the phenomena, but by delivering a massed attack on each section in turn, perhaps success can be achieved more easily.

I suggest the following as a possible segregation:

(1) The physical forces governing the formation of bubbles in a pulp.

(2) The physical forces governing the attachment of bubbles to sulphide particles in a pulp.

(3) The physical forces governing the stability of the bubble attachment.

(4) The physical forces governing the stability of a bubble at the free surface of the pulp.

Leaving out of consideration those processes in which bubbles are formed in a pulp by the chemical action of one substance on another, and also Mr. Norris's unique process, in which minute bubbles are 'born' in a pulp which is super-saturated with a gas, and regarding only those processes in which a gas is introduced directly from an external source, segregation No. 1 will be found to present a considerable problem.

Several of your correspondents appear to be laboring under the delusion that it is simply necessary to introduce air violently into a pulp either by agitation or blowing, and immediately bubbles of the right number and kind obligingly form themselves. Anybody who has had practical experience with flotation, especially with the so called air-froth flotation, knows that most unfortunately this is not the case. No amount of agitation or blowing will produce bubbles of the right kind and number in absolutely pure water. A contaminating agent is necessary, and as some of the contaminating agents commonly used happen to be oils, concentration by frothing most unhappily has been named 'oil-flotation,' thereby masking the real significance of the use of the reagent. The action of certain substances in producing innumerable minute bubbles when air is introduced forcibly into a pulp, seems to be of fundamental importance, since without these bubbles the most common forms of froth flotation cannot be considered.

Professor Pollock of Sydney University, in Australia, has done some very interesting and useful work on this all important subject, and I believe has formulated a theory. I once saw a set of instantaneous consecutive photographs of bubbles, taken by him, showing their formation after the introduction of a blast of air. With

pure water the bubbles were mostly large, and even the small ones which were instantaneously produced had a tendency to collect together to form larger ones. With contaminated water the reverse was the case, the instantaneously produced large bubbles seeming to break down into smaller sizes.

From my experience in the practical application of the froth-flotation process, I am inclined to believe that many of the troubles that crop up from time to time at flotation plants are due to the inability of the reagent used to produce the required quantity of bubbles, owing to the appearance of some reactive substance in the pulp. Hence practical, as well as theoretical considerations demand a thorough understanding of the physical forces governing the production of bubbles in a pulp.

Coming now to segregation No. 2. More attention has been paid to this phase of the question perhaps than to any other, and rightly so, as it is of the utmost importance in all flotation processes, those employing the surface-film effect being excepted. Many writers pass lightly over the problem and simply state that the bubbles attach themselves preferentially to the oil or gas-filmed sulphide particles.

Let us now see whether this is possible if the two forces of surface tension and adhesion are alone considered. In the following discourse surface tension can be most simply defined as that force acting at the surface of all liquids which continually tends to reduce the surface area; and adhesion as that force which acts across the interface between two substances, which are in infinitely close contact, and tends to keep them from separating.

Consider a particle of sulphide mineral (which, for the sake of clearness, we may assume to be nearly spherical) and a bubble in close contact, in the interior of a pulp, but before the bubble has actually 'picked up' the mineral. (Fig 1). Even if the particle possesses appreciable adhesion for the water, the surface of the liquid in contact with the particle must be considered as tending to have surface tension, although the tendency is opposed by the adhesion. (See T. J. Hoover's 'Concentrating Ores by Flotation,' pages 50 to 55).

In the first case, assume the adhesion to be negligible. The surface tension forces that now come into play are shown in Fig. 1, where T_g is the gas-liquid, and T_s is the solid-liquid, surface tension. A glance at the force diagram will show that whatever the value and direction of the forces T_s and T_g , their component T_c can never be greater than $T_g + T_s$. Therefore surface-tension alone cannot rupture the intervening film, and cause the bubble to envelop the particle. If the particle possesses appreciable adhesion for the liquid, then the case is more hopeless still, as T_c must then be sufficiently

strong to rupture the intervening film and also to tear it away against the action of the adhesive force between the solid and the film.

Once a rupture has been effected, bubble attachment resolves itself into a struggle between surface tension and adhesion, the former strongly favoring a strategical retirement to the rear, from the salient, so as to straighten the line, and adhesion endeavoring to hold the right wing to its position.

As it is an established fact (See Fig. 2) (Mr. C. T.

In all probability this additional force manifests itself in the phenomenon known as the "hysteresis" of the contact-angle. Hysteresis is defined as the lagging of effect behind cause, and a contact-angle is the "effect" that is "caused" by bringing a solid surface in contact with a liquid surface in the presence of a gas. With many substances the "effect" (the contact-angle) does not assume its full value immediately, but lags behind. The reason why the angle changes can be fairly well explained if we assume that there is a force acting between a solid surface and a gas, tending to concentrate the gas on the solid surface; and that this force is strong enough to act across a thin film of the liquid.

In Fig. 3 the solid is a piece of glass, which is clean, and has been immersed for some time in the liquid.

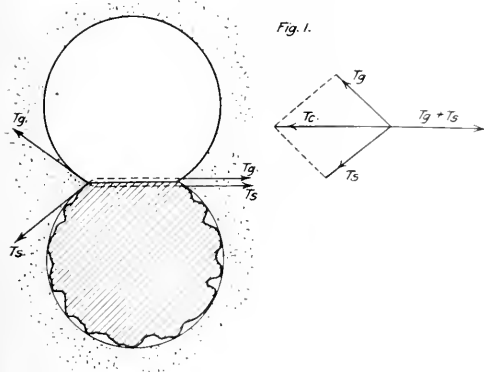


Fig. 1.

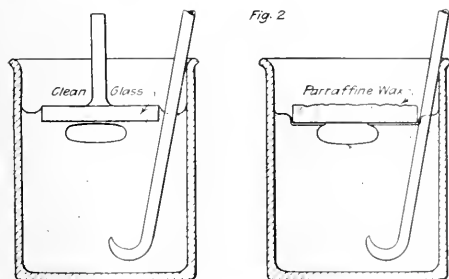


Fig. 2

Bubble unattached
Bubble-Film continuous and
Bubble perfectly mobile.

Bubble attached and
Bubble-Film discontinuous

Durell notwithstanding) that a bubble contiguous to a surface with negligible adhesion does become attached almost immediately, so that its film forms part of a continuous film covering both solid and gas, there must be some force that causes rupture of the bubble-film at the point of contact.

In the case of two plain bubbles in pure water with their films in contact, the immediate coalescing can probably be explained by the difference in vapor-pressure existing in bubbles of different radii. But we add a contaminating agent for the very purpose of counteracting this force due to the difference in vapor-pressure so as to allow small bubbles to exist in the presence of larger ones; otherwise a froth would be an impossibility. Hence some force other than the difference in vapor-pressure must be present when one of the bubbles happens to have some, or all, of its interior space occupied by a sulphide particle.

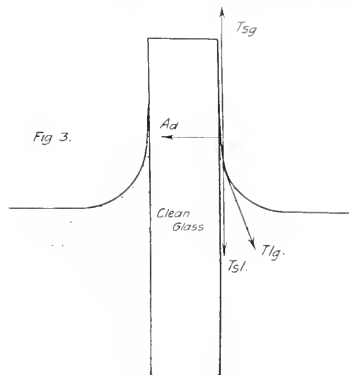


Fig. 3.

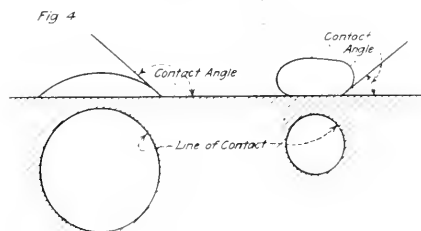


Fig. 4

On drawing it through the surface, a contact-angle is immediately formed, and for any given angle, the forces T_{sg} , T_{lg} , and Ad are in equilibrium (ignoring gravity). If now the solid possesses the power to adsorb the gas through the very thin film at the toe of the angle, the adhesion of the liquid for the glass will be lessened and a corresponding surface-tension T_{sl} set up in the direction shown. This additional force will be sufficient to upset the state of equilibrium, the toe of the angle will recede, and the angle will increase in size. The stable angle will be reached when T_{sg} , T_{lg} , T_{sl} , and Ad have such magnitude and direction as to balance one another.

It has been found that those substances which possess the greatest power to vary the contact angle also show the strongest tendency to float under suitable conditions, and it is reasonable therefore to assume that this power has something to do with the attachment of bubbles.

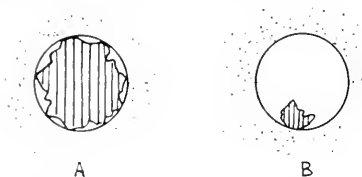
The problem presented by segregation (3) is not

nearly so formidable as that just considered; it, as already stated, merely resolves itself into a struggle between surface-tension and adhesion. With most substances in their natural states, adhesion is altogether too strong, and, even if the film at the point of contact is ruptured, the bubble cannot attach itself on account of the inability of the surface-tension to tear the solid and the liquid surfaces apart. Hence either the surface-tension must be increased or the adhesion decreased. The latter course is usually adopted, as, with dilute solutions, the former is difficult; except for very small amounts is an impossibility.

Although an absolute increase in the surface-tension is out of the question, a relative increase is possible by raising the temperature. Both surface-tension and adhesion decrease with a rising temperature, but the latter much faster than the former; one being zero at the critical temperature and the other probably zero at the boiling-point. This is one of the reasons why solids that will not collect bubbles at ordinary temperatures, will do so when the boiling-point is approached.

The usual methods employed for decreasing the natural adhesiveness of liquids for solids are:

- (a) To allow the solid to take on a film of gas by adsorption (or occlusion?).
- (b) To allow the solid to take on a film of oil or other greasy matter by adhesion.
- (c) A combination of both (a) and (b).



While collecting evidence for one of the patent lawsuits that are ever with us, an interesting discovery was made. A piece of Broken Hill sulphide ore, taken from the centre of a large uncracked block, was found to contain 0.0037% of natural grease, as obtained by an ether extract. Samples were afterward taken from several other mines, and all gave an oily residue after extracting with ether in a most careful manner. Perhaps it is just as well to add that this was discovered accidentally and was not being specially sought as prospective evidence. This discovery goes a long way toward explaining the preferential adhesion of bubbles to sulphide particles.

The tenacity with which the bubble holds the particle depends on the length of the line of contact, which in turn depends on the size of the contact-angle, itself proportional to the relative values of surface-tension and adhesion. (See Fig. 1.)

If the adhesion is negligible, and the particle is large in comparison with the bubble, the result would be as shown in Fig. A.

If the particle is small, then the result would be as in Fig. B.

As adhesion increases, the tendency is for the particle

to get more and more out of the bubble and into the liquid until the surface-tension does not act over a sufficiently long line of contact to hold the weight of the particle, and it falls off.

The problem presented by segregation (4) has been dealt with in a most excellent manner by Mr. W. H. Coghill in your issue of February 26, 1916. His remarks in regard to a lowering of the surface-tension *per se* not being essential to the formation of a froth, are most timely.

The tension that exists in a pure liquid film is unlike all other tensions with which we are familiar, in that the stress is not proportional to the strain. Within the elastic limit (that is, the limit wherein the substance will return to its original shape when the contorting force is removed) a steel rod, or, taking what is more familiar still, a steel spiral spring, needs twice the pulling force to stretch it twice as much, and so on. The well-known spring-balance depends on this fact. But with a liquid film the same force can continue to cause an extension until rupture takes place, in spite of the fact that the film, right up to the point of rupture is within the elastic limit according to the above definition.

It is plain then that our common conception of a tension must be entirely revised when we come to deal with the tension at the surface of a liquid. For a system to be in a state of stable equilibrium it must offer a greater resistance to any force which tends to change its configuration, and as a pure liquid film does not fulfill this requirement it cannot possess stability.

The extreme instability of bubble-films is strikingly shown by the phenomenon in certain boiling liquids, with which we are all painfully familiar in our student days, called 'bumping.' In the absence of nuclei on which to form, the radius of a steam bubble when it first comes into being must be infinitely small, and the vapor-pressure to balance the surface tension of these small bubbles is large. Therefore before the bubbles can expand and rise through the liquid (that is, before boiling can occur) the temperature must be raised above the natural boiling-point of the liquid. As soon as the bubble has expanded to appreciable size, the vapor-pressure of the liquid is in excess of that necessary to balance the surface tension, and the bubble expands so rapidly that it literally explodes.

A boiler does not explode until its steel plates are actually ruptured, but the bubble explodes at the bottom of the beaker, that is, while its shell is actually in existence.

In the case of a solid, the greater the tension the greater the tensile stress developed; for a material of given strength, the greater the tensile stress, the greater the chance of rupture.

This line of reasoning does not hold in the case of a liquid film. The idea that a bubble film can be ruptured by the force of its own surface tension is about equivalent to the idea that a man can lift himself by his own shoe-strings.

It is obvious from the nature of the molecular forces

engaged, that the greater the surface tension the greater the ultimate tensile strength of the film. The lowering of the tension in itself therefore cannot give greater stability to a liquid film; but the surface adsorption, which accompanies the lowering of the tension in the case of certain solutes, can.

For reasons that need not be gone into, a solute which lowers the surface tension of a liquid, concentrates at the surface of the solution, but this process of concentration (called adsorption) takes a certain definite time to reach its full value. Now, if a film of the solution be stretched, new surface is produced, and this new surface at the moment of production possesses greater tension than the rest of the surface, because the surface adsorption has not had time to reach its full value. It therefore offers a greater resistance to the stretching force, and fulfills the conditions for stable equilibrium. So strong is the adsorption factor in certain cases, that practically the whole of the solute is concentrated in the surface layers, and therefore, although the absolute quantity in the solution may be exceedingly slight, the surface effect it produces is considerable. This explains the efficacy of the extremely small amount of contaminating agent used in some froth-flotation plants.

In a mineral-froth, it is strikingly obvious that those bubbles which have their films thickly studded with sulphide particles have their stability enormously increased. In some froths, one such bubble can be seen pursuing the even tenor of its way, amid a regular holocaust of its less fortunate brethren. The reason for this is not quite clear, but it is probably due to the adhesive force between the liquid and the solid.

The above remarks are given for what they may be worth, in the hope that they may be of some assistance to other mill-men, who, like myself, are anxious to see the inner workings of a flotation process clearly, as by the light of day, but at present, only perceive them dimly, as by the flicker of a candle at the far side of a 50-ft. stope. To the mind of the ordinary mining-man, much of the reading-matter available on the theory of flotation is just about as ponderous and obscure as a bull elephant cavorting in a fog. I sincerely hope that the preceding discourse will at least cause the fog to lift a little. Our heartfelt thanks are due to Mr. F. A. Fahrenwald* for giving those gentlemen their quietus who wished to solve the problem of flotation by leading us into the mystic realm of static electricity. I think the trio, surface tension, adhesion, and adsorption, if given an attentive and intelligent hearing, will acquit themselves admirably.

THE AMERICAN INTERNATIONAL CORPORATION, formed to promote participation of Americans in foreign enterprise, will confine its activities to a semi-banking business, encouraging the financing of railroads, steamship lines, light and heat services, water-works, etc. The Corporation will maintain representatives in foreign countries but permanent expenses will be kept low.

Explosives

Nitro-glycerine is a limpid oil formed by the action of a mixture of nitric and sulphuric acid upon ordinary glycerine. This chemical action is a violent one unless carefully controlled. After it has taken place, the nitro-glycerine is washed repeatedly to remove any trace of acid that might remain. The presence of acid is dangerous in the finished explosive because it may produce a chemical action of disastrous results. For practical use, the liquid nitro-glycerine is so sensitive to percussion and friction that it is dangerous to transport it or attempt to employ it alone. However, when nitro-glycerine was first introduced for driving the Hoosac tunnel in Massachusetts, and for springing oil-wells in Pennsylvania, it was used alone, being carried in copper cans and loaded in tin tubes. In the oil-well region, men made an occupation of driving a horse and light wagon through the country for carrying the pure nitro-glycerine to the consumers. Many accidents were reported, and a carrier's position was scarcely to be envied.

Later it was learned to mix the nitro-glycerine with a quantity of kieselguhr, an infusorial earth composed of the silicious skeletons of minute diatoms, and therefore called diatomaceous earth. The nitro-glycerine is absorbed by the earth, which is itself inert and simply forms a plastic mass that can be more safely handled than the nitro-glycerine. Another advance came when it was found that nitro-cellulose, or gun-cotton, could be dissolved in the nitro-glycerine to form a nearly uniform jelly. This mixture constitutes blasting gelatine. The gun-cotton is made by the action upon cotton fibres of the same acids as are used in the manufacture of nitro-glycerine, great care being taken to wash away all trace of excess acid. When gun-cotton, or nitro-cellulose, is incorporated with the nitro-glycerine, it shares in the explosion, instead of acting as an inert base like kieselguhr. Thus additional power is gained. Blasting gelatine, then, is a mixture of two complex compounds, which fact increases the possibility of chemical change with consequent deterioration and danger. Blasting gelatine contains 92% nitro-glycerine and 8% nitro-cellulose. There are, also, various intermediate mixtures of nitro-glycerine and nitro-cellulose with a proportion of wood meal and potassium nitrate, the object being to produce effects intermediate between straight dynamite and blasting gelatine. When such a complex mixture was attempted, it was at first difficult for any mechanical method to render a perfectly homogeneous mass, but later methods of manufacture have improved this.

The initial pressure of the different explosives when detonated in their own volume are as follows: straight dynamite (nitro-glycerine mixed with an inert base) 80 tons per square inch, blasting gelatine 113 tons, gun-cotton 71 tons, black powder 21 tons. It is evident that blasting gelatine is the most powerful. Likewise it has the highest rate of detonation, 25,262 ft. per second, as against 22,368 for straight dynamite and 984 for black powder.

*The Electro-statics of Flotation, M. & S. P., Feb. 26, 1916

Platinum on the Pacific Coast

By T. W. Gruettler

SOUTHWESTERN Oregon and northern California are the chief sources of platinum in the United States. In this region it is recovered as a by-product from gold placers. At the present time the greater part of the platinum is won in the Californian alluvial flats where many dredges are at work, and where more attention is given to saving the fine metal than at the average hydraulic mine.

David T. Day says in 'Black Sands of the Pacific Slope,' a U. S. Geological Survey bulletin, on page 3: "If only two-thirds of the platinum in the heavy sands going to waste at hydraulic mines in California and Oregon were saved, the total production would exceed the present consumption of the United States."

The platinum in the sea-beaches from Gold Bluff, California, to Coos Bay, Oregon, varies from 1:20 to 1:5 as compared with gold, while in the dredging areas on the Feather and Yuba rivers it is from 1:1000 to 1:3000. Eight large samples of natural sand from Crescent City southward to the vicinity of Gold Bluff, averaged 48c. gold and platinum per ton. Eleven similar samples from Crescent City north to Coos Bay averaged 61c. gold and platinum. The largest proportion of platinum to gold, along the coast, is in the vicinity of Pt. Orford. Where the rivers cut large bodies of serpentine (dunite), the usual source of platinum, the metallic particles are coarser than on the beaches. Along the rivers they are often encased in hematite, chromite, olivine, serpentine from olivine, etc. From 20 to 50c. per yard is not uncommon.

Iridosmine, one of the platinum group carrying a high percentage of iridium, forms a higher proportion of the platinum along this part of the Coast than in any other locality in the world, one Oregon sample being 37.30%.

J. E. Kemp, U. S. Geol. Surv. Bull. No. 193, p. 19. The iridosmine is generally a mechanical inclusion in the platinum and is present as fine brilliant plates. Aqua regia will dissolve the platinum from the nuggets, which then fall apart and leave the fine plates exposed.

As usually found, the platinum will pass a 20 mesh screen. It cannot be separated from the heavy black sand by means of riffles. The flakes of platinum and gold drift over the surface of the black sand and will not concentrate easily. At mines where all the heavy sand is saved, it is sometimes panned by hand or shipped to a smelter. As platinum will not amalgamate, gold can be separated from it with ease. When the miner ships the black sand to a smelter, the platinum is not paid for. Some mines, by table or centrifugal concentration, will keep a rich product for shipment, discarding the tailing, which is a wasteful method. Digs and hydraulic classifiers are also used, particularly on dredges, to improve a

low-grade concentrate, the coarse concentrate being ground fine to release the precious metals. This refers to inland placers where the sand is coarse.

Occasionally low-grade black sand is treated with quicksilver to get at the gold, and then sodium is added to make sodium-amalgam and the platinum extracted with this. However, the sodium soon decomposes and often lets go of the platinum before it is collected. Electrolytic sodium-amalgam is also used and is the only practical success known to me. Panning is a tedious and expensive process. When machine concentration is used, it is generally carried too far, a concentrate being made that is worth, say, \$3000 to \$20,000 per ton. Of course, this usually gives only a few pounds of concentrate, the greater part of the valuable contents being lost in the tailing, which are discarded.

Within recent years dredging and hydraulic mining companies have given more attention to close saving but except where electrolytic sodium-amalgam is used, there is still a large loss of platinum and coated gold, as well as gold amalgam from 'flouring' and 'sickening.' There are immense areas of rich sand where the gold and platinum are flaky and coated. These can be worked with electrolytic sodium-amalgam at a handsome profit, as described already.* The treatment is preceded by a two-stage concentration process, the concentrate being made no richer than can be done without excessive loss in the tailing. A 95 to 100% recovery is not unusual. The cost ranges from a fraction of a cent to several cents per yard, to which concentration is added. Concentration on a 2400-yd. basis would be about 2c. per yard or less. Mining costs run from 1c. to 10c. per yard in ordinary cases. In this system there is no loss from oxidation of sodium, coatings of silica, oil, slime, oxides, etc., unless the metallic particles are wholly encased. With the present high prices for the platinum metals it would pay many mines to add electrolytic amalgamation to their equipment. First costs vary from \$500 to \$3000 in addition to concentration machinery. The new system has been much improved and a high degree of efficiency and simplicity has been attained. The correct design of the apparatus is a somewhat complicated matter, but once installed, anyone can run it. I have not patented my improvements and would be pleased to give further details on application.

As already stated, platinum is mostly derived from serpentine. Prospectors should test deposits of chromite in serpentine. A simple and reliable test is as follows: Have your druggist order 1-oz. stannous (tin) chloride crystals; 1 package 4-in. white filter-paper; buy from

*M. & S. P. November 6, 1915.

him a bottle two-thirds filled with strong hydrochloric acid, another with nitric acid; a third for dissolving the stannous chloride (bottles should be about 1 or 2 oz. each with glass stoppers); two droppers and several 5c. test-tubes complete the outfit, which should not cost over \$1 nor weigh over 1 pound.

In a test-tube put a small pinch of finely-powdered ore or sand; drop on this four drops hydrochloric acid with one dropper and two drops nitric acid with the other dropper, taking care not to draw the acid into the rubber bulb, and washing. Warm contents of tube gently with a match held on the side, keeping mouth of tube pointed away from your face. This will dissolve most of the gold in a few minutes. If not testing for gold, this solution may be poured away. Add fresh acid in the same way and pour off all but enough to well cover the sand. Boil with several matches. Then pour what is left of this solution over a piece of filter-paper. From the stannous chloride bottle pour a little over the filter-paper. Where the two solutions meet on the paper a bright orange color will appear if platinum is present. The gold solution crossed with the stannous chloride gives a red-purple or brown-purple color, according to concentration. If both metals are present, both colors will appear and the intensity of color is in proportion to concentration and richness. The tin crystals are dissolved with water and hydrochloric acid, about half and half. Leave the bottle open occasionally, as this produces stannic chloride and improves the action.

FOREIGN TRADE is becoming important to mining and manufacturing companies in this country. Since the War has called attention to it, interest has arisen as to how such business is transacted. How our exports of copper are marketed in Europe, how tin is bought in London and shipped direct from the Straits Settlements, how mining machinery can be sold in South America or Russia, all these questions have exercised the minds of those engaged in American industries. The trade at American ports, particularly New York, has increased greatly, and efforts are being made to retain permanently the new ties of foreign business. The National City Bank of New York points out, in a recent publication, how London has built up its commercial supremacy. Two principal reasons are given. First, because the port was free to all the world with few restrictions or encumbrances. Secondly, because shippers in remote countries had confidence that a cargo of anything, sent to London and consigned merely to the general market, would receive fair and expert treatment in storing, grading, and sale to buyers that would speculate in any product. A shipper could draw immediately on a consignee and receive part payment.

THE MINING LAW of this country contains a stipulation that discovery of a valuable mineral must be made prior to locating a claim. Regarding this, Horace A. Winchell, the well-known authority on mining law, has remarked "In other country, so far as I am aware, re-

quires a prospector to make an actual discovery of mineral in place before staking out his claim. The more you think of it, the more absurd it becomes. A prospector is a man searching for mineral. He must necessarily be protected in his possession while he is searching for his vein, but under the present law he is a trespasser upon the public domain until he has found his vein. Twenty-five years ago it was perhaps an easy matter to make a discovery without any prospecting work. Today it is exceedingly difficult." This was said in discussion of a paper by Courtenay De Kalb in a bulletin of the American Institute of Mining Engineers.

Zinc is temporarily more important than copper in the Central or Middle-Western States, says a press bulletin of the U. S. Geological Survey. The zinc production of the Mississippi valley was worth \$17,139,264 in 1914 while the copper output of the Central States, mostly from Michigan, was \$21,865,043. But for 1915, the value of the zinc produced reached the remarkable figure of \$53,540,472, or over three times that of the previous year. The copper production increased to \$46,494,969 and more than doubled in value. The value of the copper produced in the Central States had for years exceeded that of zinc, owing to the higher price per pound received for the copper, while the quantity of zinc produced has been larger. In 1915, the output of copper in the region mentioned was 101,300,000 lb., greater than in 1914, but the low figure for 1914 was partly due to a disastrous strike of copper-miners in Michigan. The 1915 output of zinc exceeded the 1914 production by only 95,700,000 lb., but the proportionate increment in price of the zinc was greater than for copper. "The salient facts relating to zinc and lead mining in the Central States in 1915 were the building of new mills and roasting-plants in the Wisconsin-Illinois region; the increased output and the better recovery made by flotation in the disseminated-lead district in Missouri; the more general use of thickeners, classifiers, and tables and the vastly larger yield from the sheet-ground in south-western Missouri; the development of the new mining territory near Picher and Cardin, in the north Miami field in Oklahoma; and the active prospecting and mill-building and the increase in shipments of zinc carbonate in Arkansas." It is interesting to note that two of the principal uses of spelter in the manufacture of war munitions are for galvanizing the barbed wire used in making wire entanglements and in making the brass for cartridge-cases and parts of projectiles. The average price paid for spelter in the United States during 1915 was 14.44c, which is nearly three times the 1914 average of 5.36c. Zinc has truly been the "metal sensation of the War." It is generally predicted that the reaction in the price of zinc will be more decided than in other industries, but as no one expected anything different, the event will be sufficiently discounted. Some authorities predict that after the War, zinc will drop to its former price of 5c., but others expect a price of about 7 cents.

CONCENTRATES

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

EIGHTEEN ELEMENTS have melting-points above 1700 C.

ELECTRIC HAULAGE in the Hollinger mine, Ontario, resulted in a saving of 7c. per ton in tramming charges last year.

ANACONDA, a copper producer, yielded 8,064,986 oz. of silver last year; Nipissing, a silver producer, yielded 4,097,301 oz., or about one-half of the former.

FLOTATION at the Broken Hill Proprietary Co.'s works in Australia has produced 744,816 tons of zinc concentrate from 2,988,919 tons of tailing, since 1904.

ROCK-DRILLS working in the Homestake mine, South Dakota, number 575. There is 4500 lb. of dynamite used daily. On two 8-hour shifts 1200 men are underground, extracting 4500 tons of ore.

AN ASSAY-FURNACE burning crude-oil at the Rosario mine, Honduras, effects a saving of P500 to P600 per month over a charcoal type, and also allows the work to be done in two-thirds of the time.

WOOD-FLOUR and wheat-flour refuse, worth about \$15 per ton, are used in the manufacture of dynamite to absorb nitro-glycerine. Flour of a good white color is preferred, as dynamite is judged for freshness by its light color.

WOUNDS should not be treated with mercuric chloride dressings, if iodine has been applied. The consequence would be the formation of mercuric iodide, which is strongly irritating. To remove mercuric iodide, wash the wound with a 10% solution of potassium iodide.

CHROMITE, or iron chromate, usually called chrome-iron ore, is used in chemical manufacture to make salts used in tanning, also for a refractory lining employed in basic open-hearth steel furnaces, more particularly where the silica brick arch meets the magnesite lining of the hearth. Most of the present supply to this country comes from New Caledonia and Rhodesia. The high ocean-freight has given a market to the California product, obtained chiefly in Shasta, Tehama, Tulare, and Fresno counties. The chemical trade demands a 15-55% ore, for refractory brick a 35-40% ore will suffice.

TO ALLOW TAILINGS to flow where they may without obstruction, is to risk the loss of any valuable metal retained. If they lodge on the lands of another, they are considered as an accretion and belong to him. If they accumulate on vacant and unappropriated public land, it has been the custom of the mining regions of the West

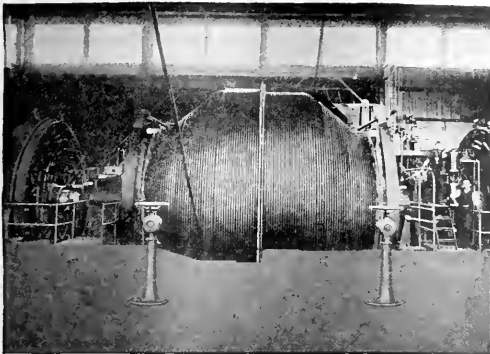
to recognize the right of the first comer to appropriate them by proceedings analogous to the location of placer claims. The Supreme Court of Nevada ruled that, although not a mining claim within the strict meaning of the expression as generally used in this country, a "tailing claim" is so closely analogous to it that the propriety of subjecting the acquisition and maintenance of the possession of it to the rules governing the acquisition of the right to a strictly mining claim at once suggests itself. The Land Department has recognized this possessory right and permitted entries to be made on lands containing beds of tailings, under the law applicable to placers. There are no adjudicated cases in the reports of department decisions upon this subject that have come under our observation, but we have knowledge of several instances where patents for this class of claims have been issued under the mining laws.

WOODEN BLOCKS, creosoted, which are already used extensively as paving material for city streets, are coming into use as flooring for warehouses, factories, shops, platforms, etc. Floors made of wooden blocks placed on end are noiseless under heavy traffic, durable, sanitary, and easy on the feet of workmen. The high cost is a disadvantage, being \$2.40 per square yard for the completed floor. The wood commonly employed is Southern yellow pine, although hemlock, larch, Douglas fir, black gum, beech, and maple are also used. The blocks are sawed from long sticks of timber and are treated in steel cylinders of 6 to 7 ft. diam. and 100 ft. long. Creosote-oil is run into the cylinders, and pressure is applied to force it into the wood. The oil is a product obtained from the manufacture of coke from coal. Wood saturated with creosote does not decay, shrink, or swell to the extent customary with untreated wood. The blocks are laid usually on a concrete foundation, with the grain of the wood vertical so that the most resistant surface is exposed. The joints and cracks are filled with hot pitch or asphalt.

DUST LOSSES in smelting plants should be investigated, and a systematic study usually proves worth while. Although the advantages of this work are fairly obvious, the limitations should not be overlooked. Estimates of dust losses by any methods at present in use are subject to considerable errors. The average of a number of tests is a close approximation to the truth. One set of tests gives a figure that applies to the particular operating conditions of that time only, and no estimates can safely be made from it of dust loss under different operating conditions. In using the results of these tests, a probable error of 10% is allowed at the Copper Queen smelter at Douglas, according to J. M. Samuel in a paper prepared for the A. I. M. E. Changes will probably improve methods from time to time; but in measuring the dust content of a flow of gas in a conduit, variations in flow and composition of gas, under ordinary operating conditions, are so great that the average of a number of tests rather than individual tests will always have to be depended on for accuracy.

Electric Hoists on the Rand

*Exclusive of winches there are 143 electric hoists at the Rand mines, their combined continuous rating being over 74,000 hp. Power is obtained from local steam plants, the largest of which are those of the Victoria Falls Power Co., which have a total capacity of 220,000 kw. (This concern originally intended to generate power at



VIEW OF COMPLETE HOIST.

the Victoria falls on the Zambesi river, nearly 700 miles distant from Johannesburg, but the difficulties of transmitting high-voltage current over such a distance were so great that steam plants were decided upon near the mines.)

Near the centre of the region is the property of the Crown Mines, which in 1915 produced 763,061 oz. of gold from 2,497,000 tons of ore. Reserves are estimated

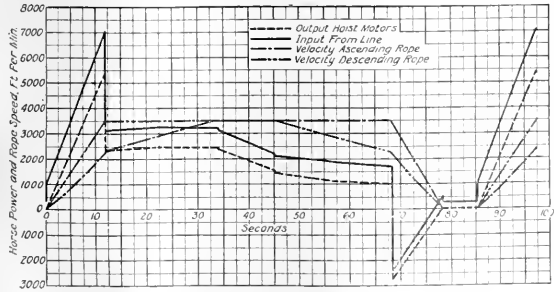
Number of turns of rope on cone.	25
Maximum speed, revolutions per minute.	53.5
WR of revolving parts of hoist (less motors), pound-feet	15,816,000
Time for acceleration, seconds	12
Time for retardation (assumed), seconds.	10
Rest period, seconds	7
Weight of skip, pounds	8,700
Weight of ore per trip, pounds.	16,000
Size of rope, inches diameter.	2
Weight of rope per side, pounds.	22,300

As will be seen by the photograph, direct-connected to the drums at each end is a 22-pole, 2000-hp., 53.5-r.p.m., 550-volt, shunt-wound motor. The remainder of the electric apparatus includes a 4-unit, motor-generator set consisting of one 16-pole, 5000-hp., 375-r.p.m., 2000-volt induction motor; two 14-pole, 1650-kw, 375-r.p.m., 550-volt shunt-wound generators; and one 60-kw, compound wound exciter together with the necessary control apparatus. The hoist motors and generators operate in series.

The accompanying chart shows operation of the hoist when lifting from the 3540-ft. level. It was found that when winding from the deeper levels the apparatus did not heat as much as when hauling from the upper levels. While hoisting from the higher parts of the shaft the rope never leaves the cylindrical portion of the drums; on the other hand, while lifting from deeper levels the conical effect of the drums is used.

Tin is least important of the metals from a military standpoint. It is used in war munitions only for a minor part in British shrapnel, and some other metal could undoubtedly be substituted. The recent high price cannot be laid to war consumption, but rather to the uncertainty of supply because of high ocean freights.

Tin, which is now selling around 41c. per pound, sold for an average of 42c. during 1913, for 37c. during 1914, and for 39c. during 1915. The *Daily Metal Reporter* of New York remarks that "it is indeed fortunate that tin is not an absolute requisite in the manufacture of munitions of war, for it is a relatively scarce metal compared with iron, copper, lead, and zinc." The import of tin into the United States during 1915—and this country is the greatest consumer—was 57,000 tons or about 1000 tons per week; this figure is only a fraction of our output of copper or zinc. The new smelter of the American Smelting & Refining Co. at Perth Amboy, New Jersey, is now smelting Bolivian concentrate. The process includes roasting in a Wedge furnace and smelting in a 12 by 38-ft. reverberatory provided with oil burners. Refining is done electrolytically—a new departure in tin making. The output averages 99.97% fine, which is better than the famous Straits tin, and the capacity is 15 to 20 tons per day, approximately 10% of the consumption in this country.



DUTY-CYCLE WHEN HOISTING FROM 3540 FEET.

at 9,938,000 tons of \$6.25 ore. Over a year ago a General Electric hoist of the following construction was installed at the South Rand shaft of the company, the shaft being 3540 ft., inclined at an angle of 90° to the horizontal, according to notes by F. L. Stone:

Type of drum.....double cylindro-conical
Diameter of rope centres at small end of drums, feet 12
Diameter of rope centres at cylindrical end of drums, feet 20.75

TALC production in 1915 was 166,336 tons worth \$1,041,197.

*Abstract from *General Electric Review*, June, 1916.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

SUTTER CREEK, CALIFORNIA

PIMMING AT THE EUREKA.—LINCOLN AND OTHER MINES TO BE RE-OPENED.—CENTRAL EUREKA AND KENNEDY.

Two of the three sinking pumps have been installed in the old Eureka shaft and are discharging a large stream of water. The compressor and other parts of the plant are working well. So far operations have been done only on one shift, but the shaft crew has been increased and on June 20 work began on three 8-hour shifts. As the water is lowered, the shaft-timbers are found to be in an excellent state of preservation, notwithstanding the fact that the last work done at the mine was during 1886; in fact, it is said that much of the sets will not have to be renewed, now that the cave at the collar of the shaft has been caught up. Miss Marguerite Beam formally opened the mine by blowing the whistle last week, on the day the pumps



RE-OPENING THE OLD EUREKA AT SUTTER CREEK.

were finally coupled up and put into operation; it was a sound most welcome to Sutter Creek residents.

The sale of the well-known Lincoln group of mines to men interested in the old Eureka property was confirmed late last week, the purchase price being given as \$295,000. The sale includes the Lincoln mine proper, as well as the Wildman, Mahoney, and Emerson claims. With the exception of some prospecting at the Lincoln a few years ago, no work has been done on this stretch of mining ground for over 10 years, financial difficulties having caused the closing down of the mines and their subsequent loss by the last operators. The assistant United States treasurer, W. J. McGee, and other local men are largely interested in the present deal, as they, incorporated under the name of the Lincoln Consolidated Mining Co., came into possession of the combined properties after the old company's failure to raise the funds necessary to pay off mortgages and equip the property for development. The mines have been opened by four shafts: the Wildman, 1400 ft. on 72° incline; Emerson, 619 ft. vertical; Mahoney, 1200 ft. on 62° incline; and Lincoln, 2000 ft. on 63° incline. The intention of the former management was to sink the Emerson vertical shaft down to the point necessary to cut the large vein found in the Wildman property on the 1400-ft. level. This shaft was

sunk in diabase 1000 ft. east of the Wildman, and the expectation was to cut this great orebody at a vertical depth of 2300 ft. This vein at 1400 ft. in the Wildman was opened for 160 ft., solid quartz assaying over \$3 per ton, and should be made to yield a good profit with proper working facilities. Two 40-stamp mills are on the property, but owing to their old style and dilapidated condition, they, with most of the other equipment, will have to be replaced with modern machinery. The Wildman and Mahoney plants were formerly driven by water-power, the company owning a large reservoir and pipeline for this supply. The purchasers are said to be Michigan men of whom T. Hoatson is one of the principals. T. Walter Beam, president and manager of the Eureka, has taken formal charge of the Lincoln property, and such tools and supplies as will not be immediately needed at the Lincoln are being transferred to the Eureka. The Wildman claim adjoins the Eureka ground and underlies the town of Sutter Creek.

At the Central Eureka 70 men are employed, where 20 stamps of the 40-stamp mill are in steady operation on ore from the 2800, 3000, and 3100-ft. levels. Some development is contemplated at 700 ft., and preparations are in progress for sinking a winze below the 3200-ft. level in accordance with suggestions made by C. E. Juhlén, who examined the property recently for the purpose of outlining the mine's future development. Fred Jost of San Francisco is superintendent.

At the Kennedy mine at Jackson, preparations are nearly completed for sinking the shaft to a depth of 3900 ft. This vertical shaft is now said to be the deepest of any gold mine in the United States, and the ore developed on the lowest levels is quite as rich as that worked in the levels above, insuring the stockholders handsome quarterly dividends.

WASHINGTON, D. C.

MINING ON INDIAN RESERVATIONS.—MINING LAW.

A bill, prophetic of what may take place some day, is that of Senator Ashurst of Arizona before the Senate to authorize mining for metalliferous minerals on Indian reservations in Arizona. It directs the Secretary of the Interior, under regulations to be fixed by him and under such terms and conditions as he may prescribe, to lease to citizens of the United States or to any associations of such persons or corporations, any part of the unallotted lands within any Indian reservation in Arizona, withdrawn from entry under the mining laws, for the purpose of mining for deposits of gold, silver, copper, or other minerals, the leases to be irrevocable except under such breaches provided against in the bill. Ninety days after enactment of the bill the lands are to be open at all times for exploration for minerals, the claims to be located in the same manner as mining claims are located elsewhere under the mining laws of the United States. It is provided that the locators or their heirs or assigns shall only have a preference right to apply to the Secretary of the Interior for a lease within one year after the date of location, and that any locator who shall fail to apply for such a lease shall forfeit all right to his mining claim.

The leases are to be for a period of 50 years, with the preferential right to renew them for successive periods of 10 years under conditions and terms to be prescribed by the Secretary of the Interior. Relinquishment is also provided for, should the locator desire to give up his claim. On application by him

he may also acquire during the term of the lease a tract of unoccupied land, not exceeding 20 acres in area, for campsites, milling, and smelting works, and for other purposes connected with the proper development and use of the deposits covered in the lease. For the United States the right is reserved to dispose of the surface of the land embraced within the lease, in so far as the land may not be necessary for use of the lessee in extracting and removing the deposits of the land. Leases may be canceled and forfeited by the Government by appropriate proceedings in the United States district court. For the privileges of mining the lands the lessee is to pay to the United States a royalty of 2% of the gross value of the output of the minerals, payable at the end of each month succeeding the extraction of the mineral from the mine, and an annual rental, payable at the date of the lease, of 25c. per acre for the first calendar year, 50c. for the second, third, fourth, and fifth year, and \$1 for each succeeding year during the continuance of the lease. In addition it is provided that the lessee shall expend annually not less than \$100 in development work for each mining claim located and leased. The Secretary of the Interior is given full power to examine the books and accounts of all lessees and to require them to make statements, all under oath. The money from all royalties and rentals is to be deposited in the Treasury of the United States to the credit of the tribes of Indians having tribal rights in the reservations in which the leased land is located. The rights of all States and local authority is conserved, such as collection of taxes. Senator Ashurst has also introduced a bill in the Senate authorizing the Secretary of the Interior to lease for the production of oil and gas ceded lands of the Shoshone and Wind River Indian reservations in the State of Wyoming, the moneys resulting to go to the Indians, and the regulations to be fixed by the Secretary of the Interior.

Nothing has as yet been done by the committee on mines and mining of the House of Representatives on the bills providing for the codification of the mining laws of the country. The committee seems to have gone asleep over the matter, in spite of its enthusiasm manifested early in the winter. Those in charge, however, appear quite impressed with the many caustic letters that have been received in criticism of the so-called Foster bill codifying the mining laws. It seems almost assured that no codification bill will become law in this Congress.

TORONTO, ONTARIO

PORCUPINE, KIRKLAND LAKE, AND COBALT.—STEEL.

At Porcupine the Dome management has definitely decided to substitute ball-mills for stamps, and has ordered three more machines of the 8 ft. by 20-in. type already found highly satisfactory.

Construction on the 2000-ton per day addition to the Hollinger mill has been started the contracts having been let for the concrete foundation.

Diamond-drilling at the West Dome is showing excellent results. Four veins have been cut, the last at a depth of 700 ft. below the surface, being 10 ft. wide and heavily mineralized. The shaft is down 227 ft. on a vein, carrying free gold, and will be sunk to the 300-ft. level.

The McIntyre has cut a 16-ft. vein on the 1000-ft. level. This may be an extension of that previously found at the same depth of the McIntyre Extension.

Frank L. Culver, president of the Timiskaming and Beaver companies of Cobalt, has acquired a large interest in the Schumacher, and has been elected a director of the company.

At the Vipond the shaft has been connected by a raise from the 400 to the 300-ft. level, making the high-grade ore on the lower level accessible for hoisting to the mill.

Developments at the Porcupine Premier, formerly the Standard mine, 100-ft. level have been encouraging. A number of Boston people inspected the property on June 3.

At Kirkland Lake good progress is being made with the development of the Labelle Kirkland. This embraces 265 acres, across which run several dikes believed to contain rich ore. The shaft is down 330 ft. on a high-grade vein which has persisted all the way, and will be followed to a greater depth. A station has been cut at the 270-ft. level.

The Lake Shore has opened ore containing free gold and tellurides on the 300-ft. level, and the vein is thought to extend into the Teck Hughes property.

The mill of the Tough-Oakes is treating about 120 tons of \$20 ore per day. The company is laying out a townsite to the north of the mine.

Large shipments of ore were made from Cobalt last week, the total amount from 10 companies being 454 tons. Total bullion shipments for the year to date were 3,225,545 oz.

The Trethewey mill is again in operation, treating broken ore that was formerly left in the mine because of the low price of silver when the mine closed down.

The Kerr Lake has taken an option on the Maidens property in South Lorrain, where it is thought that there is a considerable body of low-grade ore.

The annual report of the Peterson Lake for the year ended April 30 shows a total income of \$393,183. After paying dividends, \$277,376 was carried forward. This was practically all derived from royalties paid by the Seneca Superior.

The Ophir and the Peoples mine have effected an agreement for the joint development of their properties down to the contact of the Keewatin and diabase at a depth of approximately 600 ft. The surface of both mines shows a number of strong veins with low silver content.

Steel plants in the Dominion are very busy, mainly on war and export orders. One result of this unusual activity is a shortage in the output of steel rails, which is greatly retarding railway construction in the West. The annual report of the Dominion Steel Corporation of Sydney, Nova Scotia, for the year ending March 31, shows the largest profits in its life. The net manufacturing earnings were \$7,004,316, an increase of \$3,433,258 over the previous year. After all deductions for interest, depreciation, and dividends the net surplus remaining was \$3,015,225. One-half of the total output of the year was exported.

Two Cobalt, Ontario, silver producers in 1915:

	La Rose Mines	McKinley- Darragh- Savage Mines
Development, feet	4,393	4,538
Ore reserves for mill, tons.....	10,000	.....
Ore reserves, ounces .....	.....	1,871,280
Ore milled, tons	54,165	63,661
Average content, ounces	15.28	17.165
Recovery, per cent	76.7	80.9
Ore and concentrate shipped, tons..	17,105	18,938
Silver content, ounces	1,071,694	1,197,815
Net value received	\$481,663	\$515,101
Cost per ounce, cents.....	31.64	28.71
Net profit	\$230,662	\$231,433
Balance brought forward.....	\$1,032,811	.....
Dividends paid	\$228,000	\$269,723
Balance carried forward	\$886,850	\$280,299
Silver shipped to date, ounces.....	22,891,968	15,183,661

The general manager of the La Rose, R. B. Watson, reports that only a small amount of high-grade ore remains in pillars, but in clearing-up the mine other small shoots will be found. Some dumps should yield a small profit.

At the McKinley-Darragh-Savage, T. R. Finnane is manager. Ore reserves in the McKinley were maintained, but as the property has been thoroughly prospected the chance of finding other important orebodies is slight. Before the Savage mine's possibilities are exhausted a considerable amount of exploration remains to be done.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE

Contrary to general belief, the Federal government has withdrawn from lease only a small area of the Matanuska and Bering river coalfields. There has been surveyed over 200 sections of 640 acres each, and under the law the Department of the Interior is authorized to withdraw 19 of these sections, but it has not done so, according to the *Anchorage Daily Times*.

The mine inspector, Sumner S. Smith, who has been in conference with Franklin K. Lane in reference to the leasing regulations, is of the opinion that the entire field, with the exception of Government reservations, will be open to lease. Applicants can go on the ground and designate any area they desire to lease, subject, of course, to the usual mode of procedure. Regulations governing the leases are based upon the idea of the immediate development of the coalfields on an extensive scale, and to prevent speculators from getting hold of the land. Those who are willing to spend the most money on the development of a mine will be given the preference in the granting of leases. Mr. Smith believes that the coal can now be mined on a workable basis, and an important resource of Alaska fully developed.

Reports from Anchorage state that a large number of men are going to the new placer strike at Tolstoi in the Innoko district, many centres in the Kuskokwim valley losing their population. Dogs have risen in price 200%. As usual, opinions differ as to the prospects of the ground. A town-site has been laid-out at the mouth of Boob creek. The distance by water from Iditarod to Cooper, the new town, is several hundred miles, but the diggings can be reached by dog-team traveling cross-country in a 60-mile journey.

JUNEAU

Satisfactory progress is reported in construction of the treatment plant of the Alaska-Juneau company. At the coarse-crushing plant concrete work has been completed, and steel is now being erected. Good progress has also been made with concrete work on the mill and power-plants.

ARIZONA

COCHISE COUNTY

Water from the precipitating plant at the Lowell mine of the Copper Queen is to be pumped into stopes containing low-grade sulphide ore to dissolve the copper. This will be returned to the surface for precipitation on iron as usual, and returned to the mine continuously.

GLA COUNTY

It is reported in Boston that the Old Dominion company is to spend \$1,000,000 on additions to its mill, power-plant, and smelter, also for residences. This will be spread over some time.

At the Inspiration mill some of the sections are treating over 1000 tons per day each; their rated capacity is 800 tons. Improvements to the Macey mills have helped to do this. The last of the Colorado and Joe Bush ore-dumps have been cleaned up and sent to the mill. Underground work is evident by the large craters forming on the surface near the shafts. Drainage of the ore-body is well ahead of sto, in.

GREENLEE COUNTY

Although the Arizona Copper Co.'s employees have signed an agreement with their employers, as did also those at the other mines in the Clifton-Morenci district, yet last week some men at the Coronado mine, Humboldt mine, and No. 6



KING INCLINE OF THE ARIZONA COPPER CO. AT METCALF.

concentrator called a strike without authority. A Mexican mucker at the Coronado, considering that he had done enough work for the shift, downed tools before the regular time; others followed his example. After some argument with the superintendent, this resulted in the mine being closed. The grievance committee investigated the trouble, two men were discharged, and the mine resumed. At the Humboldt a man was discharged for some reason, whereupon the next shift refused to work unless he was re-instated. The grievance committee's efforts were fruitless, and the mine, with the concentrator, was shut-down. Eventually the difficulty was settled, and operations re-started.

MARICOPA COUNTY

A plant to treat gold, silver, copper, lead, and zinc ores by amalgamation, concentration, flotation, and cyanidation, is to be erected at an early date at Wickenburg.

MOHAVE COUNTY

(Special Correspondence.)—Activity at Oatman is largely confined to the southern end, particularly to that part known as the Pioneer vein system. This formation extends into the Oatman Pioneer from the Arizona Tom Reed. Work at the latter is still largely prospective, but some good results have been obtained. The main shaft is down 100 ft., and a 5-ft. vein assaying around \$10 has been cut. Greater depth will be obtained, as on the same vein in the Pioneer good ore was not obtained until depth was reached. On the 200 and 400-ft. levels in the Pioneer ore is being followed toward the Arizona Tom Reed ground with good results.

Another active property is the Paramount, joining the Pioneer on the south-east. At present the principal work of the company is confined to the erection of surface plant at the main shaft, which is sunk directly on the vein. Excavating is under way at the mill-site and for the hoist. A contract has been let for a 60-hp. electric hoist, and it is expected that the transformer will be running in 60 days. Two shifts are working in the mine. The shaft is down 70 ft., and is to be sunk to 300 ft. The drift at this point will be watched with interest, as it will settle several theories regarding the formation of the vein system in the southern end of the district. In the Paramount the drift will be driven toward a junction of several well defined and proved veins, one coming from the Arizona Tom Reed and the Pioneer, and others from a more southerly direction. The question is whether high-grade ore will be found at this junction.

The vein system of the southern end of the district is peculiar and interesting. It comes from the east in the Lexington Arizona as one large lode, which branches out in that property to big veins, one of which passes into the Boundary Cone and the other into the Paramount, both of which properties join the Lexington on the west. The more southerly vein again branches out in the Paramount, one of which goes into the Pioneer and the Arizona Tom Reed and others in a more southerly direction. As yet but little prospect work has been done on these junctions.

Oatman, June 19.

The Elkhart gold-silver-lead mine in the Chloride district has been acquired by the A. S. & R. Co. The property has a past production of \$1,300,000, and has been idle for 12 years. The workings are flooded, and unwatering is under way. The Tennessee zinc mine adjoining is owned by the U. S. S. R. & M. Company.

YAVAPAI COUNTY

In the Shamrock mine of the New State group of claims, 8 miles south of Prescott, 6 ft. of \$19, 14 in. of \$276 ore, and a dike of \$7 gold ore has been opened. This is one of the best developments for some time. A number of promising mines are near-by.

In an interview with the *Jerome News*, W. A. Clark of the United Verde company said: "We will increase the output of our plant here as soon as the all-steel fireproof smelter at Clarkdale is placed in full operation. The smelter is the latest word in the construction of a metallurgical plant. More houses will be built at Clarkdale. Additional school facilities will also have to be built, but I never regret money spent for schools. Butte, my home city, has more schools and better equipment than any town of its size that I know. In Jerome, arrangements will have to be made to take care of the additional force that will be employed when the smelter is in position to operate at capacity. The Verde district certainly has encouraging prospects. A few good mines will result from the numerous corporations that are forming here this year."

YUMA COUNTY

It is probable that the Swansea smelter will be re-started for custom ore. The plant has been examined by A. C. Cole.

ARKANSAS

MARION COUNTY

The north Arkansas field yielded 5,000,000 lb. of ore during May. Seventeen of the forty mines produced zinc carbonate, which was shipped direct. At Rush the Yellow Rose mine has a 100-ton mill at work.

CALIFORNIA

BUTTE COUNTY

The Bear Canyon manganese mine at Clipper Mills has been closed on account of a dispute between the owner, G. Woolley, and the Noble Electric Steel Co., which is operating it for its smelter at Heroult, Shasta county. The ore is high grade. Woolley is opening a good deposit of chrome-iron near-by.

CALAVERAS COUNTY

(Special Correspondence.)—The McKnight Mining Co., operating the Hamby mine, is making many surface improvements. A 650-cu. ft. Sullivan compressor and motors have been installed. A 20-stamp mill, with concentrators and amalgamator, are almost completely erected and housed in a corrugated-iron building. Electricians are nearly through with the wiring and the plant will soon be ready for work. The hoist for the present will be driven by steam generated with fuel-oil. It is contemplated in the near future to use a motor, using steam as auxiliary power. Luther Everitt is superintendent.

The Mokelumne Mines Co., a subsidiary company of the International Investment Syndicate of Los Angeles is now operating the Easy Bird mine at this place, together with adjacent property, covering an area of 400 acres. A 457-cu. ft. Ingersoll-Rand compressor, driven by electric power, has been installed. A 75-ton plant with amalgamators, concentrators, and classifiers will be installed soon, and a cyanide plant for treating concentrate on the ground, may be erected. A contract has been let to John Casey and Herbert Blais for the construction of a road from the mine to the public highway, whereby freight to and from the mine may be hauled to Martel station by auto-trucks. For the present ore will be milled from the upper workings, above the adit-level, where a good body of \$8.50 ore has been blocked out. Work will soon be commenced on a three-compartment shaft, by raising from the adit-level about 350 ft. to the surface and by sinking from the same point. An electric hoist will soon be installed. A. M. Howat is superintendent and H. J. Wendler is manager.

Work, Sharpe, and Reade are re-opening the Xmer adit in Stockton hill. This is a 2000-ft. tunnel into the Ancient Channel mine, and it is expected that the gravel will be reached about July 1. The property is equipped with a Boise gravel mill, which has a capacity of about 90 tons per 24 hours. Water from the Mokelumne Hill canal will supply power and for washing the gravel. H. E. Sharpe is in charge of the underground work, and F. B. Work will attend to surface operations.

Mokelumne Hill, June 19.

KERN COUNTY

The Baltic mine and mill and the Buckboard claims near Randsburg have been sold to Los Angeles people headed by A. O. Hunsaker, J. C. Woodmancy, and L. H. Harrod for \$100,000. The mill is to be remodeled.

NEVADA COUNTY

At Ormonde, above Washington, 160 acres of patented ground has been acquired by the Columbia Consolidated Mines Co., of which E. C. Klinker is manager. The company's

area is now 430 acres. The Ocean Star and German mines were also bonded by the company.

Amalgam was stolen from the plates at the Black Bear mill near Rough and Ready last week. Quicksilver was also taken.

Lumber and machinery amounting to \$70,000 has been ordered by C. A. Brockington of the Grass Valley Consolidated Gold Mines, to be used in re-opening the Allison Ranch mine. R. L. Hathaway, of Nevada City, will erect the buildings. The Taylor Foundry & Engineering Co. will supply some machinery, Wellman-Seaver-Morgan Co. the electric hoist, American Deep Well Co. the electric pumps, and Sullivan Machinery Co. the compressor, etc.

SAN BENITO COUNTY

A plant of 250-ton daily capacity, consisting of a ball-mill and tables, has commenced treating quicksilver ore at New Idria. Most of the ore comes from the company's San Carlos mine, which is of considerable promise, is at a much greater elevation than the plant, and is being connected with it by an aerial tram about $1\frac{1}{2}$ miles long. The cinnabar in the San Carlos occurs differently to that in the Idria, where narrow veins are the rule. Three furnaces are also at work treating over 300 tons daily.

SHASTA COUNTY

Zinc ore amounting to three carloads daily is leaving Kennett for smelters in Kansas. A car of blister copper is sent East every day.

The Mammoth Copper Co. is to erect an electrolytic plant to treat the zinc fume caught in the furnace flues. Wages will be lower in June on account of the drop in price of copper during May.

SIEIRA COUNTY

For the sum of \$5200, part of the North Fork-Wisconsin property near Forest has been purchased by the North Fork Mining Co. Both companies had claims on one another and settled disputes amicably. The Wisconsin is to open its gravel-claim from a certain point, while the North Fork opens its vein through an incline. D. E. Hayden and G. F. Stone are the respective managers.

SOLANO COUNTY

A farmer, W. Hawthth, and others have erected a large drilling outfit just north of Vallejo. A hole will be put down to 1700 ft. to test the ground for oil. The prospecting will cost \$30,000.

TRINITY COUNTY

From its property near Wild Wood the Manganese Company of California is to extract 10,000 tons of chrome ore this summer. This will be carried on auto-trucks, over a road to be improved to Redding.

YUBA COUNTY

Near Parks Bar on the Yuba river the Yukon Gold Co. has 50 men constructing its new dredge.

COLORADO

CLARK CREEK COUNTRY

(Special Correspondence.) Flotation at the Argo mill, Idaho Springs, Colorado, is giving remarkable results. Custom ore containing copper, lead, gold, and silver yields 9% of its metal-content. A good recovery is made on carbonates. Free gold is also said to be floated. The medium is 85% of Wyoming fuel-oil and 15% of pine-oil.

Idaho Springs, June 18.

At Georgetown the Capital mill is working regularly.

GLENNSON COUNTY

At Vulcan the Vulcan Mines & Smelter Co. has blown-in a new furnace. Sulfide copper ore from the Vulcan-Good Hope mine is to be reduced. C. H. Mace is in charge.

LAKE COUNTY (LEADVILLE)

At a point 1700 ft. from the portal of the Valley adit in Prospect mountain, and at a depth of 150 ft. below it, iron-silver-manganese ore has been cut by the interior shaft. A 50-ton lot was sent to the Arkansas Valley smelter at Leadville. This development is of great importance to the district.

At the Wolfstone shaft the water is down 100 ft. below the 800-ft. level, leaving 80 ft. to be drained.

The Penrose shaft of the Down Town property has been unwatered to the bottom, namely, 874 ft. Work commenced on May 8, 1915. A Providence Manufacturing Co. centrifugal pump of 3000-gal. capacity, against a 900-ft. head, is being installed. It is to be driven by a 650-hp. G. E. motor. The present flow is 1700 gal. per minute.

OURAY COUNTY

The Benack Mining Co. is to drive a new adit, 500 ft. below the present outlet.

SUMMIT COUNTY

A car of ore, 27 tons, in three lots, assaying 10.5, 97.5, and 1470 oz. gold per ton, also some silver, worth a total of \$30,000, was shipped last week from the Dunkin mine near Breckenridge to the Globe smelter at Denver. The sampling company devoted 10 days to sampling the lot. Gayman, Knorr, Whar-ton, and Summers are the lessees.

TELLER COUNTY (CRIPPLE CREEK)

The well-known Cresson mine has been sold to Colorado and New York capital for \$1,270,000. A. E. Carlton negotiated the deal. The Colorado men in the purchasing syndicate are Charles M. MacNeill, Spencer Penrose, Eugene P. Shove, John C. Mitchell, Harry James, and Louis Noble.

IDAHO

SHOSHONE COUNTY (COEUR D'ALENE)

The Marsh Mining Co., which has been operating near Burke until two weeks ago is to be reorganized as the Consolidated Marsh Mines Co., capitalized for 2,000,000 shares at \$1 each, against the 1,500,000 shares in the old company. The new corporation will take over all the holdings of the company, the Green Mountain Mining Co., of which the Marsh has control, and probably some adjoining properties, the extent of which has not been decided on.

An 18-in. shoot of galena has been opened on the 1100-ft. level of the Hypotheek mine near Kingston. The new 125-ton mill is doing good work.

MICHIGAN

THE COPPER COUNTRY

(Special Correspondence.)—The committee of Lake Superior shareholders of the Centennial company, formed last year to attempt to bring about a plan for consolidation with the Osceola Consolidated, has dropped operations for the present. They have information to the effect that G. M. Hyams of Boston is a shareholder in Centennial, although not owning the stock so that it shows on the books. Under the circumstances they think that if they made their proposal to the Osceola—both corporations being under Calumet & Hecla management—Mr. Hyams would be almost sure to bring some sort of court action that would prevent consummation of the deal, no matter how fair the shareholders of the Centennial or those of the Osceola might look at the proposal. Their assumption in that direction is due to the court action which Mr. Hyams took against the Tamarack's consolidation, when that plan and price of purchase of Tamarack stock by the Calumet & Hecla was considered fair by practically every Tamarack stockholder.

Houghton, June 19.

In the Tamarack and C. & H. business the latter will only grant until July 1 its time-limit for completing the purchase.

Mr. Hyams would not waive an appeal from the decree of the Court now hearing the case.

MISSOURI

The ore market last week showed little change. The output of the Missouri-Kansas-Oklahoma district was 7639 tons of blende, 64 tons of calamine, and 979 tons of lead, averaging \$68, \$49, and \$80 per ton, respectively. The total value was \$666,456.

Losses caused by the heavy rain (6 in. from 10:30 p.m. to 4 a.m.) on June 19 amount to \$500,000, half of which was at the mines. Three men were drowned in the Coral mine, near Chitwood. The Grace mill, of 200 ton capacity, also near Chitwood, was struck by lightning and destroyed by subsequent fire. There were 3500 telephones put out of commission.

MONTANA

BROADWATER COUNTY

Developments at Copper City are reported to be encouraging. The Three Forks company has a shaft down 400 ft., cutting good veins. Good equipment has been erected. Power is available from the Montana Power Company.

SILVERBOW COUNTY

At the Butte & Superior, according to the general manager, J. L. Bruce, development of the 1700 and 1800-ft. levels shows larger and higher-grade orebodies than the 1600-ft., though on that level the ore-shoot is 1600 ft. long. During the last five years the mine has produced more than 1,250,000 tons of ore from the levels above 1600 ft., and above that depth there is more ore than was blocked-out when the company took hold of the property. Ore reserves are so large that the mine can go on producing zinc at its present rate of 180,000,000 lb. annually indefinitely. The lower price of spelter has reduced the value of concentrate; in January the product was worth \$101.60 per ton, in May \$65.25. The May output was 11,658 tons of concentrate from 50,688 tons of ore. The mill is being re-modeled to increase the capacity by 50%. Ball-mills are to be installed in place of some rolls. Foundations are being prepared for the new hoist and primary crushing plant.

The Davis-Daly is producing 100 tons of 2.5 to 6% copper ore daily, the better grade coming from 2500 ft. depth.

Development at depth in the North Butte is said to have been disappointing of late.

The Bullwhacker mine is sending 100 tons of 4% copper ore to the Pittsmond, or East Butte smelter, daily. Regular shipments also go to Tacoma and Garfield. Development is satisfactory, and costs are low.

Re-organization of the Butte & Bacorn is proceeding satisfactorily, nearly \$264,000 being available for resumption of work.

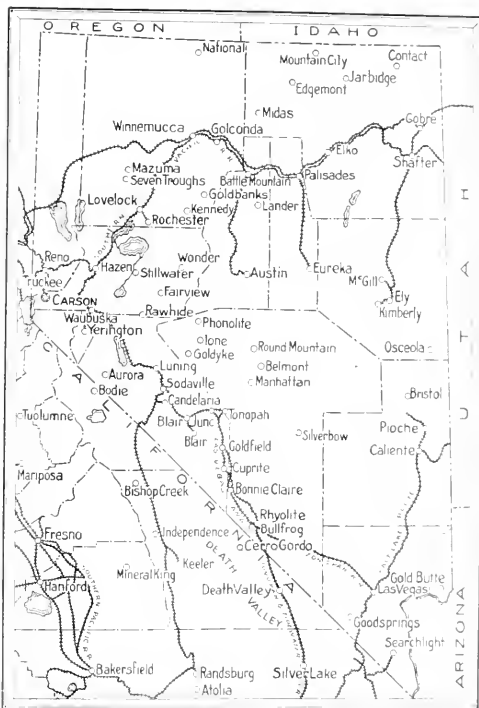
NEVADA

According to Victor C. Heikes of the U. S. Geological Survey, who recently visited Nevada, there is optimism for the future of the zinc-mining industry, though disappointment regarding the present price of spelter, among operators in the Yellow Pine district and at Goodsprings, who are sending out a large quantity of ore. There is considerable activity, also, in the Battle Mountain district.

All of the ore-loading platforms are covered with ore from the different properties, and five dry mills are in operation. These use crushers, screens, and the Stebbins dry concentrating table, and are making a concentrate that runs about 60% lead. In the Goodsprings district they are using caterpillar trucks for hauling ore, each truck carrying 30 tons of ore per trip. These and the narrow-gauge railroad are kept busy. The Yellow Pine Mining Co. is producing a heavy tonnage. The placer fields in the Battle Mountain district are being vigorously worked and extended. All of the larger properties, including the Glasgow & Western Exploration Co., in which

Salt Lake mining men are heavily interested, are prosecuting a vigorous campaign of development work. The Glasgow & Western company is in a process of liquidation, and Joseph Ralph, who is handling that end, expects to dispose of the property to Salt Lake interests. F. Sommer Schmidt, of Salt Lake, is in charge as general manager. The company is a British concern, in which the Coats family, thread manufacturers, are interested. The 100-ton flotation mill was started last week on the Battle Mountain Mining & Development Co.'s property in Lewis canyon. On the Greenah property, near Lodie, a station on the Nevada Central railroad, running between Austin and Battle Mountain, a remarkable vein has been opened by the Lemaire brothers. The high-grade ore carries native gold and silver chlorides. The Winnemucca Mining & Milling Co.'s 100-ton cyanide mill is about ready to begin operations. Construction has been delayed somewhat on account of the failure of the transformers to arrive according to schedule.

"Everything is prospering in the country tributary to our line," according to Frank M. Jenifer, traffic manager of the Tonopah & Tidewater railroad in the *Tonopah Bonanza*. "The



mines of the lower country around Death Valley are rapidly developing a tonnage that is all the more surprising since this is the dull period of the year. South of Beatty, I estimate there are 450 men steadily employed, and there is a good chance for the number to increase as more work is being done and more improvements installed by every company operating. The Tecopa company has just finished its concentrator that treats 75 tons daily, and, in addition to this, the company is delivering to us an average of 35 cars a month. This company owns 11 miles of standard-gauge railroad connecting it with several mines with the T. & T. tracks at Tecopa. At Grant, 12 miles east of Tecopa, I understand the company has opened one of the richest orebodies in its holdings. The Gunsight and Noonday mines are keeping up their output. At Death

Valley Junction the roaster of the borax company is running to capacity. At Baker, 40 miles north of Ludlow, one of the Riggs properties is shipping three cars a week of silver-lead ore. The manganese mine at Owls' Head that has attracted so much attention was sold recently by Alexander Yeoman to the Mollett Development Co., a steel concern of Massillon, Ohio, for \$50,000. This company is shipping at the rate of 1000 tons a month. It has put in two 30-ton Holt caterpillar tractors to haul the ore the distance of 27 miles to the railroad at Riggs. The Ithex at Zabriskie has been taken over by the Goodsprings company, and is preparing for an output of zinc ore that will almost equal the production of the parent mine at Goodsprings. This company is putting on auto-trucks, and may build a narrow-gauge line to cover the distance of 14 miles between the tracks and the mine. The company at Carbonate has had trouble in finding the right type of tractor, but now has secured one that is capable of doing excellent service. This motor came in recently, giving the company two trucks and tractors capable of delivering 500 tons per month."

CLARK COUNTY

The old Umberseat mine, known as the Carbonate King, is employing 25 men and producing zinc ore, in charge of F. A. Crampton of the White Pine Mining Co. The occurrence of zinc ore here adds considerably to the Goodsprings belt. Lead is also contained in the ore.

The Quartette gold mine at Searchlight has been sold to the Dupont Copper Co. of New York for \$120,000.

ESMERALDA COUNTY (GOLDFIELD)

Exploration in new ground is under way at 1750 ft. depth in the Atlanta. Other work on this and the 1580-ft. level has revealed considerable low-grade gold-copper ore.

Better ventilation has been secured at the Merger through its recent connection with the Jumbo Extension.

Development has been resumed at the Lone Star Consolidated in charge of Emory Arnold. Work was started at 225 ft. depth. The Silver King mine at Hornsilver has been acquired by A. H. Elftman and Eastern people.

LINCOLN COUNTY

At Freiberg, 65 miles west of Pioche, the Alamo Mining Co. has opened gold-silver-copper-lead ore in a limestone-diorite-porphry contact. This is a new and promising area.

WASHOE COUNTY

Last week the Union mine on the Comstock produced ore worth \$15,000. This included 112 tons of \$71.05 and 155 tons of \$31.81 ore from the 2100-ft. level, and 50 tons of \$18.43 ore from 2500 ft.—The Mexican mill treated 389 tons averaging \$39.20 per ton.—The Sierra Nevada continued repair work at 2400 and 2500 ft.—The Ophir and Con. Virginia advanced drifts at 2700 feet.

OREGON

JOSEPHINE COUNTY

Grants Pass people are trying to re-start the Takilma smelter, which has been closed since 1908. About \$4000 is required to overhaul the plant, which is of 100-ton capacity. Ample ore is available.

SOUTH DAKOTA

LAWRENCE COUNTY

Gold ore is again being extracted at the Wasp No. 2. On account of water from recent rain, mining was suspended for several weeks. Dividends since January 1 total \$100,000, mostly derived from wolframite production.

The value of the gold, silver, and lead produced in South Dakota in 1915 from 33 productive mines, 10 of which were placer, amounted to \$7,597,752, compared with \$7,131,313 in 1914, as reported by Charles W. Henderson, of the U. S. Geological Survey.

UTAH

BONLEDER COUNTY

At the Lakeview zinc-lead mine on Promontory point there are 90 men employed. The May output was 800 tons netting \$16,000. Dividends, including \$5000 on May 12, total \$100,000 since October last. The lead ore averages 26%, and zinc ore 32% metal.

JACOB COUNTY

(Special Correspondence).—Under the direction of Forbes Rickard, H. M. Byllesby & Co. of Chicago has opened a large tungsten deposit near Lovelock, Nevada. Five hundred tons of scheelite has already been shipped to the plant of the Utah Minerals Concentrating Co., at Eureka, Utah. Operation of this mill has proved quite satisfactory to the management. Already several hundred tons of tungsten ore from different producers in Nevada and northern Utah have been treated. The management attributes the success of this plant to the elimination of stamps in favor of rolls. The extraction has been from 70 to 82%, which is expected to be increased. As it stands now the plant is probably doing as good work as could be expected, considering the class of ore received for treatment.

Ogden, June 18.

MILLARD COUNTY

Sawtooth is the name of a new gold-copper district, 45 miles south-west of Oasis on the Salt Lake Route, 30 miles north of the Beaver County line, and 50 miles east of the Utah-Nevada State line. The altitude is 8000 to 9000 ft. There is plenty of water and timber nearby. The veins are mostly found on contacts.

SALT LAKE COUNTY

An extensive deposit of molybdenite has been developed at the Alta Glandstone mine in the Little Cottonwood district. About 400 sacks are ready for milling. F. Redmond and L. S. Besley are lessees.

In Big Cottonwood canyon the American Consolidated Copper Co. has cut 30 in. of copper ore at a point 1200 ft. in from the portal of the adit.

SUMMIT COUNTY

Further trouble is brewing for the Silver King Consolidated at Park City, whereby Solon Spiro, one of the directors, and the company are sued by J. C. Dugan for the return to the company of 72,180½ shares and \$87,205.20, plus 20,000 shares and \$20,000, alleged to have been wrongfully obtained and appropriated by Spiro. The plaintiff owns 9000 shares in the company. The details are somewhat complex.

CANADA

BRITISH COLUMBIA

Ore sent to the Trail smelter is increasing in volume. In the week ended June 19 the total was 10,826 tons. For 23 weeks the total is 224,472 tons.

A large quantity of zinc carbonate ore is being opened in the Hudson Bay mine near Salmou. Shipments of 60 tons daily average around 30% metal. The cross-cut adit to open the vein at a depth of 1750 ft. is in 600 feet.

During April the Standard Silver-Lead company at Silverton received \$95,115 from 729 tons of lead ore and concentrate, also \$26,847 from zinc sales. The profit was \$86,773. The surplus is \$320,926, after distributing \$50,000.

On June 30 the Hedley Gold Mining Co. pays a quarterly dividend of 3%, plus 2% extra.

ONTARIO

The Beaver Consolidated shaft is down 1630 ft. Cross-cutting is to be done at 1600 ft. to explore above and below the contact. At 530 ft. a 4-in. shoot of rich ore has been opened for 20 ft. A flotation plant may be added to the mill. In

May there was 186,433 oz. of silver in storage, and 108,050 oz. in ore. Cash amounted to \$92,484. On April 29 a dividend absorbed \$60,000. During the quarter ended May 31 the company did 1868 ft. of development.

YUKON

The Silver King mine in the Mayo district has been sold by T. Aitken to Manley, Ives, Price, and McGinn, well known in the North. When the mine is in order and roads passable, a daily output of 15 to 20 tons is expected. During the winter Aitken mined 1700 tons worth up to \$200 per ton. This deal is considered one of the most important in years.

KOREA

The Seoul Mining Co. reports the following results for May:

Bullion	\$49,140
Concentrate	55,660
Total recovery	\$144,800
Expenses	55,000
Operating profit	\$89,800

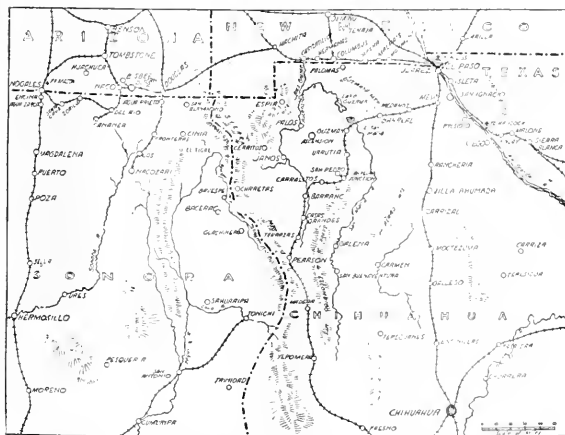
Copper is calculated at 18c. per lb. The recovery of this metal was 92.6%.

The Oriental Consolidated company's May yield was worth \$132,000.

MEXICO

SONORA

Practically all Americans have left Cananea. Their departure was made quietly and secretly, the Mexicans being in the dark as to movements made. General Calles issued a note



THE UNITED STATES-MEXICO BORDER DISTRICTS.

to the Mexican population ordering them to respect the Americans and their property.

Americans from El Tigre are also in Arizona. Loyal Mexicans will continue to operate the mine and mill until compelled to suspend work. Bullion was brought across the border safely last week, also concentrate from Nacoziari.

Many hundreds of Mexicans are passing through Agua Prieta on their way south.

The LAKE SUPERIOR MINING INSTITUTE will not hold its usual August meeting, but will meet January 20, 1917, when the iron mines are not so busy, for making a trip to Birmingham, Alabama.

PERSONAL

Note: The Editor invites members of the profession to send pictures of their work and appointments. This attention is a direct invitation to others.

MYSON L. S. WESSEL has returned to Smuggler, Colorado. HORACE V. WINCHELL passed through San Francisco on June 24.

ROBERT HAWKHURST sailed from New York for Nicaragua on June 23.

O. G. ENGELDER has returned for a visit in the United States from Sardinia.

STEPHEN BIRCH was married on June 24 to Miss Mary Rand of Minneapolis.

RAYMOND SPERR is with the Keweenaw county road commission, Michigan.

W. H. STAYER has opened an office in the Krise building, Lynchburg, Virginia.

R. B. BURNSMADE has returned from Mexico and is at St. Louis, 4429 Morgan street.

HUGH ROSE, resident manager of the Santa Gertrudis, is at Williamstown, Massachusetts.

J. D. SPERR has resigned as mining engineer to the Tom Reed Gold Mines Co., Oatman.

P. S. HARRY, mill superintendent of the Seoul Mining Co. of Korea, is at the St. Francis hotel.

E. FLEMING L'ENGLE has been appointed manager of the Royal Zinc Co. at Joplin, Missouri.

R. S. PRATT, superintendent of the Iola zinc mine in Kansas, recently visited at Houghton, Michigan.

A. J. CLARK, who is operating tungsten mines at Bishop, California, was in San Francisco this week.

HARRISON A. DENX, a graduate of the Michigan College of Mines, is reported to be in prison in Mexico City.

P. J. JANSEN, manager of the Simau mine, Sumatra, Dutch East Indies, is here on a metallurgical journey of observation.

FRANK A. LOVE has been appointed superintendent of the Elkhart mine, at Chloride, Arizona, recently acquired by the A. S. & R. Company.

F. W. SPERR is attending the annual meeting of the Society for the Promotion of Engineering Education held at the University of Virginia.

W. E. THORNE has entered into a new contract for two years more with the Lenskoie Company of Siberia, for selecting dredging and hydraulic ground and sampling same.

THEO. C. DENIS has been released from service in the French army at the request of the Canadian government, and will reserve his position as Superintendent of Mines in Quebec.

ALBERT DICKSON, of San Francisco, secretary to the Washington Mines Development Co., of Douglas, Arizona, was shot and probably fatally wounded June 21 in an ambush fight with a band of Mexicans near Chuppas, State of Sonora, Mexico.

H. KENYON BURKH, chief engineer of the Inspiration Consolidated Copper Co., has completed his work pertaining to the design and construction of the plant, and will leave on July 1 for an extended vacation trip throughout the East. His forwarding address for the next few months will be care the Sierra Madre Club, L. A. Investment building, Los Angeles.

THE EDITOR will be grateful for occasional good photographs of subjects relating to mining and metallurgical operations. They should be printed on glossy paper.

THE METAL MARKET

METAL PRICES

San Francisco, June 27.

Antimony, cents per pound.....	29
Electrolytic copper, cents per pound.....	29.50
Pig lead, cents per pound.....	7.25—8.25
Platinum: soft metal, 10% iridium, per ounce.....	\$75
Platinum: hard metal, 10% iridium, per ounce.....	\$79
Quicksilver: per flask of 75 lb.....	\$85
Spelter, cents per pound.....	15
Tin, cents per pound.....	43
Zinc-dust, cents per pound.....	30

ORE PRICES

San Francisco, June 27.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$1.25
Chrome: 10% and over, f.o.b. cars California, per ton.....	12.00—14.00
Manganese: 50% product, f.o.b. cars California, ton.....	20.00
Manganesite: crude, per ton.....	7.00—10.00
Molybdenum: 50% and over, per pound.....	0.60—1.15
Tungsten: 60% WO ₃ per unit.....	30.00—35.00

Tungsten producers and dealers at Boulder, Colorado, are more hopeful of the market. W. M. Long is paying \$30 per unit to lessees, and \$25 at the mill for other concentrate. The Boulder Tungsten Production Co. is buying from lessees at \$10.

A moderate amount of business has been done in New York from \$30 to \$35. Russia is reported to be a buyer at slightly over \$30. France has been seeking to buy in the United States, Japan, and South America, despite a statement that she has a maximum price of \$13.50 per unit.

Silica bulletin of the U. S. Geological Survey is available. During 1915 the average price of quartz was \$3.20 per ton for crude and \$10.50 for ground, \$18.60 for tripoli, and \$8.40 for diatomaceous earth.

Gypsum prices averaged \$2.70 per ton in 1915.

EASTERN METAL MARKET

(By wire from New York.)

June 27.—Copper is dull, re-sellers making the market; lead is firmer on export enquiry; spelter is dull and easy.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
June 21.....	61.25
" 22.....	65.00
" 23.....	66.87
" 24.....	66.12
" 25 Sunday.....	65.75
" 26.....	66.00
" 27.....	65.49
Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 57.58 48.85 56.76	July 54.90 47.52
Feb. 57.53 48.15 56.74	Aug. 54.35 47.11
Mar. 58.01 50.61 57.89	Sept. 53.75 48.77
Apr. 58.52 50.25 61.57	Oct. 53.12 49.40
May 58.21 49.87 74.27	Nov. 49.12 51.88
June 56.13 19.02	Dec. 49.27 55.34

The movement of prices has been upward but sensitive. When large quantities of silver are purchased in England and Europe for coinage, and there is a lack of competitive buying and sales from India and China, the price recedes somewhat. The large requirements of the mints practically guarantees producers a good price for their metal. Stocks in London are 6,550,000 fine oz., a large part of which is immobile.

If war commences between the United States and Mexico about 25% of the world's production will be unavailable.

A 15c dividend has been declared by the Tomopah Mining Company.

TIN

Prices in New York, in cents per pound.

Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 37.85 31.49 41.76	July 31.60 37.38
Feb. 39.76 37.23 42.60	Aug. 30.20 34.37
Mar. 38.19 48.76 50.50	Sept. 33.10 33.12
Apr. 38.19 48.75 51.49	Oct. 30.46 39.00
May 38.29 39.28 19.10	Nov. 32.51 29.50
June 30.72 40.26	Dec. 33.69 38.71

Tin is easy at 10 cents.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
June 21.....	37.75
" 22.....	37.50
" 23.....	37.25
" 24.....	37.00
" 25 Sunday.....	36.75
" 26.....	36.75
" 27.....	36.75
Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 14.21 13.60 24.30	July 13.26 19.99
Feb. 14.16 14.38 26.82	Aug. 12.84 17.27
Mar. 14.11 14.80 26.65	Sept. 12.02 17.69
Apr. 14.19 16.64 28.02	Oct. 11.10 17.90
May 13.97 18.71 29.02	Nov. 11.75 18.88
June 13.60 19.75	Dec. 12.75 20.67

Dividends declared are \$2 per share by Granby Consolidated, \$2 by Inspiration, \$1 by Isle Royale, and \$4 by Osceola. Tennessee passed its quarterly on account of trouble at its acid plant.

Kennecott produced 10,500,000 lb. in May, Granby Consolidated, 4,727,929 lb. and Miami, 4,600,000 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
June 21.....	6.85
" 22.....	6.80
" 23.....	6.75
" 24.....	6.75
" 25 Sunday.....	6.75
" 26.....	6.75
" 27.....	6.75
Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 4.11 3.73 5.95	July 3.80 5.59
Feb. 4.02 3.83 6.23	Aug. 3.86 4.67
Mar. 3.94 4.04 6.23	Sept. 3.82 4.63
Apr. 3.86 4.21 7.70	Oct. 3.60 4.62
May 3.80 4.41 7.38	Nov. 3.68 5.15
June 3.90 5.75	Dec. 3.80 5.34

The U. S. S. R. & M. Co. has declared \$1 per share on common and \$7½c on preferred stock.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
May 31.....	73.00
June 6.....	72.50
Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 39.25 51.90 222.00	July 37.50 95.00
Feb. 39.00 60.00 295.00	Aug. 80.00 93.75
Mar. 39.00 78.00 219.00	Sept. 76.25 91.00
Apr. 38.90 77.50 141.60	Oct. 53.00 92.90
May 39.00 75.00 90.00	Nov. 55.00 101.50
June 38.60 90.00	Dec. 53.10 123.00

Good sales of quicksilver have been made to England and Japan. The revival of export business in this metal and reduction of local stocks tends to higher prices.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
June 21.....	13.50
" 22.....	13.25
" 23.....	13.25
" 24.....	13.00
" 25 Sunday.....	13.00
" 26.....	13.00
" 27.....	12.75
Monthly averages	
Jan. 1914. 1915. 1916.	1914. 1915. 1916.
Jan. 5.14 6.50 18.21	July 4.75 20.54
Feb. 5.22 9.05 19.99	Aug. 4.75 14.11
Mar. 5.12 8.70 18.40	Sept. 5.16 14.14
Apr. 4.98 9.78 18.62	Oct. 4.75 14.05
May 4.91 17.03 16.01	Nov. 5.01 17.20
June 4.84 22.20	Dec. 5.40 16.75

The New Jersey Zinc Co. has reduced prices of its three high-grade brands by 8c, per lb., namely, from 25 to 17c, 24½ to 16½c, and 24 to 16 cents.

Eastern Metal Market

New York, June 21.

Quotations are lower, and the market dull in every metal but one—aluminum. Consumers of copper, zinc, lead, tin, and antimony appear to be waiting, marking time, as it were, to see what is going to happen. Meanwhile prices decline in the futile attempt to induce action.

The copper producers' quotations show evidence of softening, but up to the present second-hands are taking what little business there is. To a considerable extent the scarcity and inefficiency of labor is restraining consumption of the metals. Over 50 metal-working plants in and around Newark, New Jersey, are grappling with strikes. Common labor is so scarce that unskilled men can be fussy about what kind of work they do.

Zinc is neglected. The lead market is basing some hope on a revival of foreign business, but so far it has not materialized. Consumers of tin cannot be interested. Antimony is weak at 18 cents.

Aluminum, alone, shows an advance, credited to export buying.

Consumers, both domestic and foreign, are taking deliveries against their large purchases of recent months, and quiet is perhaps to be expected, but seldom has inactivity been so uniform in all the metals.

The steel trade continues to find less new business. A peculiar phase of the situation is that Bessemer steel is more easily obtainable than open-hearth, this applying to plates, shapes, and bars. Japan has been a large buyer of ship-plates, while Italy has been a large buyer of pig-iron. Russia is buying large quantities of metal working machinery in this market for manufacture of all kinds, largely automobile works and ship-yards. The domestic machinery market is quieter, with the demand for smaller tools predominating.

COPPER

Second-hands have continued to make the market in copper, but they have enjoyed but little business, with the exception of odd and scattered lots for which they have accepted 27c., cash, New York, where electrolytic was specified for prompt delivery. Lake is absolutely nominal at about 27.75c., although the price might be put at a lower level with safety. There is evidence that the producers are getting tired of the inactivity, and some of them, at least, are willing to sell at prices not much higher than those which re-sellers ask. The entire market is inconsistent. The one outstanding feature is the intense dullness. There is no new war business reported. The belligerent countries are staying out of the market presumably for the reason that they are now taking deliveries against their heavy purchases of a few months ago. As for domestic manufacturers, they are covered, in fact some of them have more copper than they need, especially in view of the unsatisfactory conditions which exist with respect to labor. Not only is common labor scarce, but once found it is inefficient and independent. Despite the fact that common labor is paid more than in years heretofore, workmen do not hesitate to leave employment for no other reason than that they find the work "too hard"—work which men in ordinary times are glad to do. The London market for electrolytic is dull, and the quotation is lower at £138 for spot (June 19). Exports from June 1 to 20 totaled 23,917 tons. The copper trade is, of course, watching the Mexican situation closely, but so far it has exerted little influence on conditions. It is conceded that should war be declared, production at several mines in Mexico might be suspended unless military protection were provided. The consensus of opinion is that it would not greatly increase the demand for copper.

ZINC

There is little to say except that buyers are not showing the least interest in the metal. A few small sales of prompt zinc have been made at 12.50c., New York, equal to 12.25c., St. Louis. Consumers seem determined that quotations shall dip still further before they take hold. July is to be held at about 12c., New York, August at 11.75c., and September at 11.30c., but futures are even more severely neglected than spot. The London market is steady, but inactive, at £68. Exports to the 20th total 2946 tons.

Sheet-zinc continues at 20c., carload lots, f.o.b. mill.

Dispatches from the Joplin, Missouri, district state that floods have caused many mines to shut-down, as was noted in the PRESS of last week.

LEAD

In the past few days the lead market has been tinged with hope based on a slight revival in export inquiry, coupled with the Mexican situation. But, the fact remains that prices have continued to decline, and that little business has been done, on either foreign or domestic account. The A. S. & R. Co. continues to quote 7c., New York, and 6.92½c., St. Louis, while independents are asking 6.62½c., New York, and 6.45c. St. Louis. Naturally the latter are taking what little business there is stirring. The sellers are in comfortable position in respect to their order books, but at prevailing prices they would be glad to book more business. Domestic consumers are well covered, however, and the war business has vanished. The London market is slightly higher at £31 7s. 6d. (as compared with a week ago). Exports for 20 days total 1798 tons.

TIN

Buying has been insignificant, and prices are lower. Spot Straits could be had yesterday at 49.75c., prompt delivery. The supply is more than ample, a fact of which consumers seem to be well aware. They also realize that the June shipments from the Straits Settlements will be extremely large, and that an over-supply may bring prices down to a still lower level. Until the market steadies itself activity cannot be looked for. The London market is weak, also, that at the Straits. London dropped £4 today, (June 21) making the quotation £174. The market has been dull for about 7 weeks, and the end is not in sight. Arrivals, up to the 20th totaled 3350 tons, and there was afloat on that day 3877 tons. The encouraging feature of the situation is that consumption in this country is on a great scale. Tin-plate mills are filled with orders, most of them to the end of the year. No other item in steel is so active.

ANTIMONY

The bottom has dropped out of the antimony market. Efforts to sell to uninterested consumers has brought the quotation for Chinese and Japanese grades down to 18c. per lb. Foreign buying is not in evidence. Some makers of antimony face heavy losses, for they cannot manufacture at prevailing prices. In many quarters it has been felt that ordinary grades of antimony, usually worth 5 to 7c. per lb., have been entirely too high.

ALUMINUM

Good buying by Russia and Italy is credited with having stiffened the aluminum market, with the result that 63 to 65c. is now asked for No. 1 virgin metal, 98 to 99% pure.

ORE

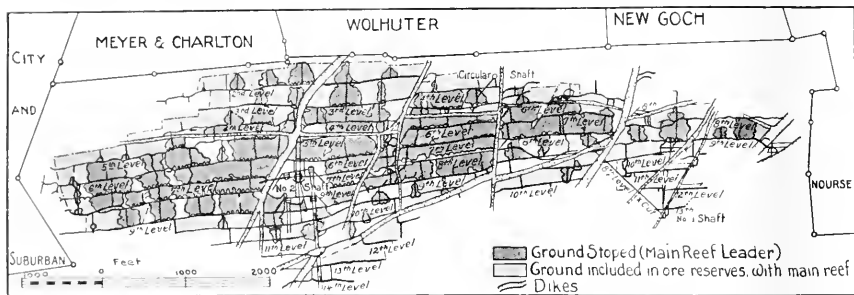
Antimony: It is reported that South American ore is no longer offered. To do so would be unprofitable in view of the low price of antimony and the high ocean freights.

COMPANY REPORTS

CITY DEEP, LIMITED

This Rand company will be remembered as one at whose mill several metallurgical experiments were made, chiefly in crushing. During 1915 there were 150 ordinary and 4 Nissen stamps operated, also 8 tube-mills, reducing 677,200 tons of ore. This averaged \$9.763 per ton, of which 66.4% was saved by amalgamation. The cyanide works treated 678,160 tons of sand and slime assaying \$3.313 per ton, with 85% extraction. A Butters filter-plant was ordered. The combined actual recovery of gold was 95.3%, against 96.3% by assay, according to the manager, Percy W. Sherwell. The year's revenue was £1,306,945, of which £624,632 was profit. Dividends absorbed £421,875. The balance for 1916 was £206,948, compared with £140,147 from 1914. Working costs were \$4.90 per ton. In 1914 the profit from 505,300 tons was £104,835, so that the past year showed a great improvement. There were 4708 natives employed.

At the mine, a section of which is shown herewith, development totaled 27,301 ft. The circular shaft is 2271 ft. vertical. Of the footage, 66% was in 'reef' formation as follows: Main Reef, 45 in. wide, worth \$3.30 per ton; Main Reef Leader,



UNDERGROUND WORKINGS OF THE CITY DEEP MINE ON THE RAND.

27 in. and \$21.10; and South Reef, 29 in. and \$14. Of the 784,150 tons mined last year, the Main Reef supplied 29%, and the Leader 71%. There was 13.5% discarded as waste. Reserves, according to the consulting engineer, E. H. Clifford, are estimated at 2,976,000 tons, worth \$9.50 per ton, an increase of 465,000 tons. The sand-filling of stopes is a success.

DOMO MINES CO.

This is one of the large companies operating at Porcupine, Ontario, and its report covers the year ended March 31, 1916. The general manager is C. D. Kaeding, with C. W. Dowsett as metallurgist. The grade of ore increased by 82c., ore treated was 99,090 tons more, and costs were 13.6c. per ton lower than in the preceding period.

Development totaled 17,359 ft., not including 5654 ft. of diamond-drilling. Exploration was fairly evenly distributed on the five main levels, with a zone 2000 ft. long, 400 ft. wide, and 700 ft. deep. Through the knowledge gained selective mining can be done, and 783,792 tons of unprofitable material was cut out of reserves. Reserves are estimated at 2,600,000 tons assaying \$6.20 per ton. On No. 7 level the stoping width shown by the first crosscut is 220 ft. On No. 5 and 6, near No. 2 shaft, there is 120 ft. width of \$6.50 ore. Two new wide zones are being developed on No. 7. The new main shaft was completed to a depth of 877 ft. All development cost \$307,000, or 60c. per ton. Mining cost 62.1c. per ton.

The mill treated 347,640 tons, yielding \$5.117 per ton with 92.88% recovery. Of this 59.04% was by amalgamation, and 33.84% by cyanidation. This is an increase, while costs decreased to 91c.

All operating charges amounted to \$2.559 per ton. From the revenue of \$1,778,959 there remained \$912,380 profit. Three dividends absorbed \$600,000. The year commenced with a balance of \$665,099, and ended with \$602,560. To bring the mill's capacity to 45,000 tons per month it was decided to add two Hardinge ball-mills (to replace 10 stamps), two tube-mills, two Pachuca agitators, three Dorr thickeners, two Merrill filter-presses, an air-compressor, hoist, head-frame, etc., the whole to cost \$282,514.

CANADIAN MINING CORPORATION MINING CORPORATION OF CANADA

The first of these concerns is an English company holding 1,911,319 shares of the 2,075,000 in the Canadian operating company. Out of dividends received from the Mining Corporation the English company distributed 30c. per share, or \$460,000 in the year ended March 31, 1916. The balance for the current-year is \$58,000.

The Canadian company owns an area of 183.5 acres in the centre of Cobalt, including the Cobalt Townsite, Townsite Extension, Cobalt Lake, City of Cobalt, and Little Nipissing

mines, also treatment plants. The consulting engineer is D'Arcy Weatherbe, and general manager, C. E. Watson. The report for the calendar year 1915 covers 44 pages, not including plans and photographs, and contains much of interest.

There was an average of 426.4 men employed at all properties, who worked a total of 133,776 shifts. Development amounted to 15,816 ft., at \$12.06 per ft., and 565 ft. of diamond-drilling. In 309.5 working days an average of 57.4 machine-shifts was worked per day. Stopping continued in the Townsite mine, and a good deal of new ore was opened, but in the west or Keewatin formation only a small area is available for exploration. In the Cobalt Lake mine the most important results obtained were along the Cobalt Lake fault, which penetrates both the conglomerate and Keewatin formations. On three levels long drifts were driven, finding some rich shoots, largely of argentiferous niccolite. Cobalt lake was drained during the year, using 5 centrifugal pumps with capacities of 450 to 700 gal. each per minute. This occupied 29 days. From April 12 to December 31, 1915, the cost of this work, including keeping the lake empty, etc., was \$25,598. The idea of this work was to render accessible ore under the lake. Present work on the Fault vein in the Cobalt Lake mine gives promise of finding more ore, but the future will probably depend on results of exploration in the north end of the property. Recent drilling proves that the underlying conglomerate is probably the deepest in the Cobalt district. Most of 1916 will be occupied in completing the work planned in this ground. Reserves

total 101,135 tons of ore, containing 3,937,995 oz. of silver, a small decrease. In the City mine are 2,312,425 oz., a large increase; 217,660 oz. in the Lake, a decrease; and 1,407,910 oz. in the Townsite, also a decrease.

The Cobalt Lake and Cobalt Reduction plants treated a total of 132,879 tons of ore, yielding 2,922,384 oz. of silver; from the 1026 tons sent to smelter the return was 1,641,574 oz., making a total output of 4,563,957 oz. The mill recovery was 90.72%. Cobalt sold amounted to 309,779 lb. The output of silver to date is 18,671,599 oz. The percentage of extraction by cyaniding ore slime and concentrate slime was 74.93.

Costs in 1915 for all departments were \$10.15 per ton and 29.57c. per oz. of silver, against \$9.16 and 30.91c. in 1914 respectively. In the latter period operations were for 9 months. The total income was \$2,632,682. The average price received for silver was 52.53c. per oz. The profit was \$1,284,141. Dividends absorbed \$518,750. The balance carried forward was \$674,645, making a total on hand at the end of 1915 of \$1,167,376.

Since April, 1914, there have been 124 properties considered, of which 70 were examined. Of the total 100 were gold, 12 silver, 5 copper, and 3 molybdenum.

The Cobalt Reduction Co.'s plant showed marked increased efficiency, raising the recovery from 80.94 to 86.51%. This was due to improvements in milling and cyaniding introduced by Mr. Fairlie. Table concentrate, 775 oz., is re-concentrated to much higher grade, namely, 2000 oz.

LENA GOLDFIELDS, LIMITED

This company controls the Lenskoie company, which operates an extensive placer mine in Siberia. The report dates with the year ended September 30, 1915. The revenue from sales of Lenskoie shares, and dividends from same, Russian bonds, royalties, loan, interest, repayment of advances by Lenskoie, and cash balance totaled £1,828,174, against £1,469,202. (The head office is in London). The net profit was 880,454 rubles (1 ruble = 50 cents), and a dividend of R.1.25 per share was paid on 1,158,297 issued. The balance to 1915-'16 was over £250,000 greater than for 1914-'15.

The consulting engineer, C. W. Purington, reported as follows: The gold recovery increased by \$5.68 per yard over the 1913-'14 result, due to improvements in washing, etc., using American methods. At the four mines 974,234 cu. yd. was washed, yielding 479,937 oz. gold, valued at £1,791,944, equal to about \$9.25 per yard. Including the gold from all sources the total value was £1,966,388, or \$9,450,000. The output to date is \$201,600,000. While the costs for 1914-'15 are not known yet, the future charges are assumed at \$6.84 per yd. Reserves are estimated at 2,238,850 cu. yd., averaging \$8.08 per yd., and 1,821,200 yd. probable, assaying \$5.32 per yd. Dredging is to be tried in the Bodaiho division, where 16,000,000 yd. exists. Further drilling is underway at that point. Costs should not be higher than in American dredging areas with similar climatic conditions. In the Nigri division is 5,200,000 yd. of gravel available for hydraulicking, worth 46c. per yd. Some preliminary washing was done there last year. The Bulbuka tributary contains 4,000,000 yd. of 5c. gravel. Winter washing was carried on successfully with the temperature at 75° F. below zero. Further electric power is to be developed. Horses were used less, and the efficiency of men increased. The War had little effect on operations.

During 1915 the Greene-Canea Copper Co.'s properties yielded 13,547,755 lb. of copper, 536,657 oz. of silver, and 3285 oz. of gold. The net income from all sources was \$1,362,606. Dividends absorbed \$500,000. The balance was \$862,606 against a deficit of \$384,208 in 1914. The continued revolution in Sonora was most annoying to the company. In spite of the small amount of development done, the ore opened undoubtedly exceeded that extracted, and there were notably larger ore reserves at the end of the year than when work resumed.

Book Review

ELEMENTS OF MINERALOGY. By Frank Rutley, revised by H. H. Read, with an introduction by G. T. Holloway. 19th edition. Thos. Murby & Co., London, and D. Van Nostrand Co., New York, 1916. P. 394. Ill. index. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$1.25.

Before the present revised edition was prepared this useful little work had 18 separate printings, 13 during the author's life. Owing to the advance in the subject during recent years, and the number of appendices added to former editions, alterations in the new work were deemed necessary. Some pertinent remarks as to the association and value of minerals is given in the introduction. After a perusal of Part I, which includes the chemistry, optical and physical properties of minerals, crystallography; and Part II, describing the mineral species, we can safely recommend this as a useful and practical book, and quite up-to-date. A note is given on flotation of minerals. In a glossary of terms used in economic geology are to be found secondary enrichment, gossan, magmatic segregation, metamorphism, sedimentary rocks, tuff, and others frequently read in technical journals.

Recent Publications

THE CAISSON AS A NEW ELEMENT IN CONCRETE CONSTRUCTION. By O. G. Aichel. Portland, Oregon, 1916. P. 32. Plans.

Engineering Experiment Station of University of Illinois, Urbana, 1916:

TESTS OF REINFORCED CONCRETE FLAT-SLAB STRUCTURES. By Arthur N. Talbot and Willis A. Slater. Bulletin 84. P. 128. Illustrated. Tests to determine the action of concrete and reinforcing steel in floor slabs of the flat-slab type of building construction.

STRENGTH AND STIFFNESS OF STEEL UNDER BI-AXIAL LOADING. By Albert J. Becker. Bulletin 85. P. 65. Illustrated. An investigation to determine the laws governing the strength and stiffness of mild steel when subjected to combined stresses at right angles to each other.

INFORME SOBRE LOS TRABAJOS DE LA COMISION DE IRRIGACION DE PERU. Por Juan N. Portocarrero. P. 46. Map, illustrated. Boletin 55 del Cuerpo de Ingenieros de Minas del Peru, Lima.

PHYSICAL GEOGRAPHY OF WISCONSIN. By Lawrence Martin. Bulletin XXXVI, educational series No. 4. P. 549. Ill. map, index. Wisconsin Geological and Natural History Survey, Madison, 1916.

Students will find this well prepared publication of interest.

ADMINISTRATIVE REPORT OF THE STATE GEOLOGIST OF VIRGINIA for 1914 and 1915. P. 45. Maps. Virginia Geological Survey, Thomas Leonard Watson, director, Charlottesville, 1916.

Second Pan American Scientific Congress held at Washington, D. C., from December 27, 1915, to January 8, 1916. The Final Act and interpretative commentary thereon. Prepared by James Brown Scott. P. 516. Index.

Every topic of importance to the Americas was discussed at this Congress, this volume being a record of the proceedings.

In a neat booklet of 32 pages, 3 by 6 in., bound with 'Faberloid,' the Dr. Pohl Fabrikoid Co. of Wilmington, Delaware, discusses 'book finish.' Leather is scarce, and an artificial product is necessary for books, automobiles, furniture, etc. Fabrikoid has proved that it wears well, and many book firms are using it. The material is water-proof and washable, also vermin-proof.

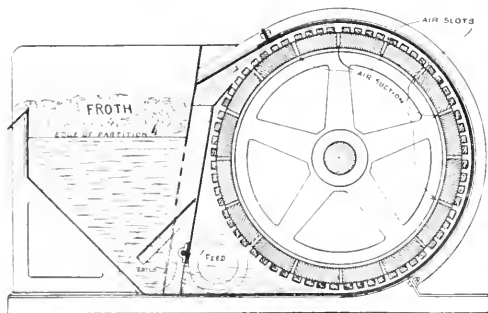
INDUSTRIAL NOTES

Information supplied by the manufacturers

The Kraut-Kollberg Flotation Machine

By MAX KRAUT

This machine was invented and designed by Mr. Kollberg and myself at Bisbee, and since has been tried successfully at various other places. Patents on the machine have been granted and others are pending. Disregarding the metallurgy of flotation, the working principle of this machine stands in striking contrast to both the agitator and pneumatic types of flotation apparatus. While the former effect the aeration of the pulp by agitating and churning, and, so to speak, beating the air into it, and the latter by blowing air under pressure through a porous medium into the pulp, the K & K machine effects the aeration by an original device, as simple as it is effective. The machine consists essentially of a long, hollow, cylindrical drum, mounted on a horizontal shaft. This drum is provided with a series of longitudinal air-slots and a larger number of longitudinal riffles running the entire length of the drum. The drum is rotated rapidly inside of a close-fitting casing, the whole being enclosed in a suitable housing, as shown by the accompanying illustration. A discharge-lip



SKETCH OF THE KRAUT-KOLLBERG FLOTATION MACHINE.

placed tangentially to the periphery of the drum provides for taking the pulp into the frothing-box and a controllable intake passage at the bottom of the frothing-box provides for returning the pulp to the aeration-chamber for re-treatment.

The operation of the machine will be best understood by following the pulp as it enters. The oiled pulp enters the aeration-chamber by the feed-pipe. As soon as the level of the pulp rises inside the aeration-chamber so as to touch the periphery of the rapidly revolving drum, it is taken up, partly by the adhesion of the pulp to the surface, partly by the skimming action of the riffles; it is taken around and immediately discharged by centrifugal force over the discharge-lip into the frothing-chamber. But any fluid moving at great speed in an enclosed passage has the tendency to produce a vacuum while in such passage and thus induce air-suction if the passage has a proper connection with the outside air. The pulp is moving in a thin layer at great speed in the narrow space between the periphery of the drum and its casing, and hence has the tendency to create a vacuum and thus induce suction, the air being drawn through the slots from the inside of the hollow drum. In turn, the inside of the drum is supplied with air through the open boxes through which the shaft passes at the two ends of the machine, as is plainly shown in the illustration. A further aeration of the pulp is effected by the suction induced by the jet or spray of the pulp

thrown off the periphery of the drum by centrifugal force at the point of discharge. The pulp, thus thoroughly aerated, enters through a number of holes which cause it to spread over the entire area of the frothing-box. The mineral froth rises to the surface and discharges over the edge of the box into a launder while the pulp settles down and again enters the aeration chamber for re-treatment through passages, the openings of which are controlled by a sliding gate. These openings are so adjusted that the pulp in the aeration-chamber can never rise above the level where it touches the periphery of the drum, thus assuring a perfect aeration at a minimum expenditure of energy, as in this manner an unnecessary and power-consuming agitation, churning, or beating of the pulp is completely avoided. The tailing is discharged through a pipe, the discharge being regulated automatically by a level-control, so as always to maintain the same pulp-level in the frothing-box. It will be seen that, as the new feed enters the machine at one end, and the tailing is being discharged at the other, the pulp gradually advances from the head toward the tail of the machine, describing in its course a spiral, as it is being re-treated repeatedly in the aeration-chamber and discharged into the frothing-box. A direct flow of pulp from the head end toward the tail end is prevented inside the aeration-chamber by rapid cross-currents, which prevent longitudinal currents, and in the frothing-box by a number of partitions, thus forcing the pulp to undergo a series of successive treatments as indicated. Except the tailing-discharge valve, which is controlled automatically, there are no other valves to be regulated or adjusted (the bottom gate being set only once); therefore the machine is self-regulating and requires no attention beyond keeping the bearings oiled properly.

The automatic-level control consists of an overflow arrangement attached to the tail end of the machine in such a way that by means of a sliding gate the overflow-level can be set at any desired height. As soon as the level in the frothing-box rises above the edge of the overflow-gate, part of the tailing overflows into a suspended bucket, which at its bottom is provided with a $\frac{1}{2}$ -in. hole. When the overflow becomes so great that the inflow into the bucket exceeds its discharge, the bucket gradually fills with pulp and begins to exert a pull on a wire or string connected to the end of one arm of a lever, the other arm of which actuates a plug or gate controlling the tailing-discharge. In this manner, whenever the level in the frothing-box rises it causes the gate or plug of the tailing-discharge to be opened. When the level sinks below the overflow edge, the overflow ceases, the bucket empties itself and the discharge-gate closes. But now it is apparent that whenever the force exerted by the weight of the bucket becomes great enough to move the discharge-gate, it will do this not gradually but will open the gate completely at once. This would cause the mechanism to open and close the gate continually, with accompanying fluctuations of the pulp-level in the frothing-chamber. To overcome this difficulty, one arm of the lever is attached to a mercury dash-pot, that is, a hollow-iron weight suspended in a pot of mercury. The hollow weight is provided with a small hole at the bottom, which permits the mercury to run in and out on very slowly. When now the bucket at the other end of the lever is exerting a pull, the mercury inside the hollow weight counter-acts the pull, gradually diminishing in force as the mercury slowly runs out of the hole. The reverse action takes place when the level sinks below the overflow edges. The mechanism is sensitive to fluctuations in the quantity of feed and readily adjusts the discharge-opening to correspond to any variations in the feed automatically, and thus contributes to the ease and facility with which this machine can be operated.

The WESTERN ELECTRIC Co. announces the death of Enos M. Barton, one of its founders, and for 20 years its president, on May 3, at the age of 72.



EDITORIAL

T. A. RICKARD, Editor



ON September 25 and following days the second National Exposition of Chemical Industries will be held in New York.

SILVER has been steady lately, at about 65 cents per ounce, with a tendency to rise. We note that *The Statist* estimates the production of Mexico in 1915 at 55,000,000 ounces, as against 70,703,828 in 1913. We question the figures for last year, believing that the reduction of output was more than is indicated by our London contemporary. By the way, the Real del Monte discovery has not yet become a source of production; it awaits further development.

SODIUM SULPHIDE is a chemical for which there is likely to be a demand, in ton lots, in consequence of the new use of it in the sulphatizing of oxidized lead and copper ores preparatory to flotation. As a by-product, it can be made profitably at soda works and similar chemical manufacturing plants, if only a demand for it becomes established in connection with flotation. Incidentally, we note that the Nipissing company is about to use sodium sulphide as a precipitant for silver in cyanide solutions, in place of aluminum, the price of which has been doubled by the demand created during the War.

LAST week we published an article on the theory of flotation; it came to us from Korea and was written by Mr. H. Hardy Smith, who explained the physical forces governing the formation and behavior of bubbles, on the basis of his work at the Suan mine. In this issue we give our readers the greater part of a paper by Mr. Robert J. Anderson, Instructor in Metallurgy at the Missouri School of Mines. This paper is to be read at the forthcoming meeting of the American Institute of Mining Engineers in Arizona; it reviews the state of the art in a useful way, touching upon the obscurities that perplex the student and operator in this new branch of metallurgy. It will be noted that Mr. Anderson refers to several articles that have appeared in our pages.

THE BIGGEST thing of its kind always attracts popular interest. We note that Mr. D. C. Jackling, in an interview, places the Chuquicamata as the biggest copper mine in the world, having regard to its present development and future prospects; he places the Utah Copper second, and the Braden third. For the time of a generation the Rio Tinto was the premier copper mine of the world, but during the last decade the development of the disseminated copper deposits and of the two Chilean properties has changed our standards of mag-

nitude. The Rio Tinto has been credited with a reserve of 100,000,000 tons of 24% ore. This was considered colossal ten years ago, but the Chuquicamata is credited with four times as much ore of about the same grade.

MOST of the cyanide used on the Rand, at the rate of 5000 tons per annum, worth about \$2,500,000, is now obtained from Glasgow. At the beginning of the War the British government arranged for a supply at a price of 17 cents per pound, which was 3 cents above the ante-bellum cost. It is announced that a new contract has been made between the principal mining groups operating in the Transvaal and Rhodesia by which a supply of cyanide is assured for five years from the Cassel Cyanide Company, of Glasgow, together with a minor proportion from the British Cyanide Company. Fortunately for the Rand and other goldfields, the restriction of silver mining and milling in Mexico has reduced the demand for cyanide from that country, the treatment of a silver ore requiring about four times as much cyanide as a gold ore.

HOW low-grade is the gold ore milled at Juneau, Alaska, is not fully appreciated. For example, the Alaska Gold Mines Co., during its ten months of operation in 1915, recovered only 94 cents per ton from 1,115,294 tons of ore, obtaining therefrom 23 cents profit per ton. Miners are accustomed to think of the copper and iron ores of Lake Superior as being the last word in low yield of metal, but a 30-ton earload of 1% copper from a Lake Superior mine contains 600 pounds of copper worth \$90, with copper at 15c. per pound, and in recent times nearly twice as much. A 30-ton earload of iron ore is worth at least \$60 at the mines and \$100 at Lower Lake points. On the other hand, a 30-ton car of \$1 gold ore can never have an assay-value of more than \$30. It is interesting to note that the three mines of the Treadwell group on Douglas island extracted nearly \$2 per ton from the 1,652,307 tons of ore treated in 1915; of this about 80 cents per ton was profit.

ZINC is being produced at the Butte & Superior mine, in Montana, at the rate of 90,000 tons per annum. This is more metal than is produced by the Utah Copper mine, just now the most productive copper mine in the world. The Butte & Superior company extracts this amount of zinc, as a concentrate, from about 650,000 tons of ore, while the Utah Copper company last year treated 8,494,300 tons of ore to obtain 78,103 tons of copper. At the zinc mine, the ore averages about 17%, while at the copper mine the average yield of metal is only 1.5%.

Ordinarily copper is three times more valuable than zinc, but in 1915, in consequence of abnormal conditions, the average price of spelter at St. Louis was 13 cents, while the copper of the Utah Copper company during that year was sold for 17.679 cents per pound. In 1914 spelter averaged only 5 cents, while copper averaged 13.31 cents per pound. In 1914 the production of spelter in the United States was 353,049 tons. The present output of the Butte & Superior is equal to one-quarter of the country's annual production before the War.

PAPER is becoming scarcer and more expensive. As a means of reducing this country's enormous consumption of paper, *Life* suggests that advertising by means of circulars be curtailed, as scarcely anybody reads them since the flood of them has become so great. A further hint is the reduction of unnecessary periodicals. Nearly every institution, organization, and cause publishes a periodical of some sort. Some of them are useful mediums, interesting to various kinds of intelligent people, but "about a million of them," says *Life*, "could be stopped entirely and no one would ever miss them." The *Congressional Record* and *G. A. R. Journal* are mentioned, and there are a great many more. Publicity for any cause, cut down to its proper proportion, can be obtained through the established periodicals. Meanwhile, if waste paper, that is paper that has served its purpose whether for wrapping or reading, were collected and saved for re-manufacture, the consumption of a national resource, wood-pulp, could be lessened considerably.

DISCUSSION this week covers a variety of topics. The first contribution asks a timely and pertinent question: "Why ship concentrate?" This is exactly what a number of managers would like to know, particularly on the Mother Lode and in the Tonopah-Goldfield region. Mr. William Macdonald, a mill-superintendent, who has had much experience in Australia, New Zealand, and Nevada, quotes the method in vogue at the Waihi Grand Junction mine, which is next-door to the famous Waihi mine, in New Zealand, and has been conspicuously well managed by Mr. W. Frank Grace. Next comes a letter on a subject discussed recently in our editorial columns. Mr. Curt N. Schmette writes frankly, and in the vernacular; we are glad to record this personal experience of a young man serving his apprenticeship in the profession, and we commend it to the serious attention of educators and managers. Many of our readers, particularly the veterans, will be pleased to see the honored name of Mr. Richard Pearce at the bottom of a note on 'Uraninite in Colorado.' We wrote to Mr. Pearce asking him to correct a recent sensationally inaccurate account of his discovery of pitchblende in Gilpin county; hence the letter and the re-publication of an article on the subject from the proceedings of the Colorado Scientific Society. Mr. Pearce's many friends in the West will be glad to know that he is living near Liverpool, where he and one of his sons, Mr. Frank Pearce, have established a successful tin smelter. The

account of his discovery of this rare mineral, uraninite, 45 years ago, suggests that Mr. Richard Pearce is in the evening of life, but we are glad to say that he retains all his old interest in minerals and metals, and men.

IT looks like another veracrusade. General Pershing has withdrawn his force three-quarters of the way home. General Trevino has surrendered the troopers captured at Carrizal, and Señor Carranza has made an evasive reply to our Government's latest ultimatum. The chances are that the present crisis will pass without war, but it bears the seed of further friction. The *de facto* government of Mexico is incapable of restoring order, and recurrent clashes along the frontier are certain. The Mexican muddle is no nearer a settlement, nor is a settlement likely until the United States, by consent or by force, intervenes.

The Gold of the Banket

An ore deposit provokes interest commensurate with its richness, that is, its content of valuable metal. We speak for the mining engineer. To the academic geologist the purely economic phase may seem less insistent than eccentricity of structure or abnormality of occurrence. It is no wonder therefore that the gold-bearing conglomerate of the Witwatersrand continues to attract technical study and scientific investigation, because the Rand, as it is called for short, produces 40% of the world's annual output of gold. Another reason for continued interest in the subject is the fact that the origin of the gold in these deposits has not yet been explained satisfactorily. No monographic official treatise of a kind comparable with those published on the Comstock, Cripple Creek, Pzribram, or Bendigo has been issued. We have had, it is true, a number of papers by mining engineers and another set of writings by geologists, but these cover various aspects of the problem without the co-ordination characterizing a single, complete and systematic investigation. Hence we are not surprised that the Institution of Mining and Metallurgy—it should be unnecessary to add, in London—gave a cordial welcome to the paper presented by Mr. E. T. Mellor, of the Transvaal Geological Survey, on the subject of 'The Conglomerates of the Witwatersrand.' We have read this essay of 62 pages and as much of the discussion as has been printed. Undoubtedly it will take an honorable place in the bibliography of South African economic geology. It represents the result of five years of conscientious work by a capable observer. Mr. Mellor's main conclusions are (1) that the gold is not confined to the beds of conglomerate now being mined, but is distributed throughout the Witwatersrand system, which is a series of sedimentary beds fully 20,000 feet thick; (2) that the extraordinary persistence of the individual beds constituting the lodes now being exploited—such as the Main Reef Leader—is due to their having been laid down in extensive deltas. Although he recognizes the probability of a re-distribution of part of the gold deposited mechanically with the conglomerate, and does

not ignore solution and re-precipitation as factors modifying the richness of the banket as an ore deposit, he concludes that the Main Reef Series represents a fossil placer. In his analysis of the conditions that must have governed the formation of these extensive beds of conglomerate, he brings to bear a large mass of evidence of an impressive kind; in short, his work as a stratigrapher is convincing. He explains the origin of the conglomerate satisfactorily. Next comes the harder problem, that of the origin of the gold associated with the conglomerate and to which it owes all its economic importance. This phenomenon, or appearance, has puzzled veteran scientists much as the milk in the cocoa-nut or the fly in the amber nonplussed the small boy. Mr. Mellor proceeds to argue that the concentration of the gold in certain particularly well-defined and continuous beds coincides with, and is probably the result of, special conditions of sedimentation; and even the distribution of the gold within these individual beds of conglomerate is considered by him attributable to the manner in which these sediments were laid down in pre-Cambrian time. He finds analogy between the Rand delta and the Nome coastal plain, which is not unreasonable, as regards processes of sedimentation, but he fails to note the entire unlikeness between the marvellous concentrations of gold constituting the raised beaches—the real fossil placers of Nome—and the broad area of low-grade conglomerate constituting the Rand. Again, he compares the pre-Cambrian conglomerate in the White Waters Range of the Transvaal with the Cambrian conglomerate in the Black Hills of South Dakota, and not without warrant, but he ignores the fact that while the Dakotan conglomerate contains gold some of which was derived, by erosion, from the Homestake vein, it is also true that the main enrichment of the latter is associated with thermal activity accompanying the intrusion of rhyolite in an early Tertiary period. However, this is not the place for detailed criticism. Another interesting feature of Mr. Mellor's presentation of the subject is his insistence on the sedimentary origin of the gold while acknowledging the later deposition, from thermal waters, of most of the pyrite and all of the other sulphides, found particularly in the younger quartz veins that cross the conglomerate beds. Obviously, the last word has not been said. The modification of the Becker-Gregory theory of a marine deposit along a subsiding shore and the substitution of a deltaic deposition is interesting, but it is not conclusive as regards the origin of the gold itself. The pyritic nodules that bothered Mr. G. F. Becker have been dissected by Mr. C. Baring Horwood in the admirable investigation described at length in the MINING AND SCIENTIFIC PRESS during 1914. The absence of ore-shoots, claimed as an argument against the theory of a lode formed by infiltration in the usual way, is not brought forward by Mr. Mellor. Indeed, the idea of uniform dissemination suited the exigencies of Rand finance better than it fits the facts as disclosed by the mine workings. Of course, the placer theory lends itself to talk of indefinite persistence of ore better than the

lode theory, for if the banket be an indefinitely huge layer of pebbles, sand, and gold, all of sedimentary origin, then it is *hors concours* indeed. But we doubt it, and suggest that before coming to a confident conclusion it will be well to study the known gold-bearing conglomerates of Nova Scotia, South Dakota, Alaska, California, and Queensland. Mr. Mellor has read about some of these; and his paper gains by his references to them. At least he has escaped the provincialism that claimed the Rand deposits as unique. The idea that any ore deposit is a special creation is unscientific. On the contrary, he will probably agree with us that every ore deposit must be studied in the light of the knowledge extant concerning kindred phenomena elsewhere.

The First Half of 1916

With commendable promptitude, the Geological Survey issues a review of the mineral industry during the first six months of the current year. "The mining man is having his innings" is a phrase that summarizes this timely appraisal of progress. The production of gold is reported as a little short of last year, but silver is being produced at a rate likely to break all previous records. The production of copper has responded to an average price, during the six months, of 26 cents per pound, so that the rate of increase noted in 1915 has continued into the current year. Arizona will maintain its first place, thanks to the splendid work being done at the Inspiration mine, among others. In Montana the total of all metallic products shows a 60% increase. Colorado has increased its copper output—which is small—by 30%, with gains in lead and zinc also. In Utah the copper produced will have a value twice that of 1915. Similar optimistic summaries come from Idaho, Nevada, and Alaska, but it is unnecessary to repeat them, our own pages having recorded progress week by week and month by month. We regret that the Director of the Survey is unable to give more precise information; his review is too evidently adapted for the daily press, which enjoys glittering generalities. However, this official dictum concerning the prosperity of the industry is intended for those detached from mining. Any observant traveler in the West during the last twelve months will have noted the many signs of expansion: cars of ore on remote railroad-sidings; old mills being re-modeled and re-fitted; the smoke rising from smelters lately idle; pack-mules passing down abandoned trails; the freight-train loaded with machinery; the refineries choked with mine products; the ships being loaded with refined metal; the engineers on their way to examine mines; and the speculator eager to talk about the price of metals. Indeed, we scarcely needed an official recognition of the fact that the mining industry of the West is thriving as never before; and, what is equally important, our pages testify to the re-awakening of technical ingenuity in the devising of new processes and the trial of new ideas in every branch of the industry. If all goes well, 1916 will be a year to make the American miner glad and grateful.

Our Economic Bronze Age

It is prudent to give serious thought to the perils of peace while the known safeties of war are still about us. Men suffered through a generation of armed peace, enduring economic hardships, poor wages, cut-throat commercialism, contracts that protected those rich enough to get such justice as suited their desires; it was a time when men feared war, and piled up armaments so massive and ominous that no one might dare to fight while everyone was equally prepared. Wise men beholding this enginery of destruction declared war impossible. It meant suicide, universal annihilation, the wiping out of the civilized nations, so that the world would need to start over again from the nucleus of surviving savages in the outer darkness of unpreparedness. The parrot world took up the refrain and 'peace the actual and eternal, war the impossible and abolished' became the chief article of faith among deluded nations. They did not recognize that we had progressed no further in genuine civilization than Isaiah, Epictetus, Luther, or Napoleon. The doctrines of pure morals and sound ethics have not been improved in any material aspect since the days of Augustus Caesar, nor have new and sounder economic bases of peace been discovered. The climax in human conceptions of the absolute moral was reached early, but the principles of a safe and sane peace have continued elusive. We are in the economic bronze age still, and many of us even reflect frankly paleolithic barbarisms of economic thought.

It was such a barbarism to think that peace could be maintained permanently by an armed menace without a mathematically exact balance of menaces. It was a similarly wild dream to think that the stimulus of enthusiasm for defense of country would awaken the dormant Mars in civilian breasts so as to match them equally and instantly against the trained millions of a prepared power. It proved a dream also, destructive of the beautiful theories of the wise ones who knew how to settle the affairs of men over their after-lunch cigars, incontestably and immutably determined, Q. E. D., to wit, that war was too destructive to be undertaken; and, when it was undertaken, that the *n*th term of the series of daily military vulcanisms necessary to destroy all Europe was thirty to guess at the extreme. Meanwhile others gained reputation for wisdom by building peace palaces; arbitration congresses fought over the way peace was to be maintained; and pacifist secretaries of state warred with non-militant presidents over the pungency of non-militant language used in explaining our pacific determinations.

The childhood of man has not yet passed away when these follies can be enacted in an epoch of armed and aggressive peace, when the struggle for trade supremacy is bolstered up by tariff walls, by subtle subventions, and by gross bonus systems, serving as the infantry of embattled commerce drawn up under cover of the artillery of protecting nations.

To affirm that armies, navies, great guns, militarism,

are all of the same breed with the economic devices whereby trade is stimulated for the sake of national aggrandizement, is no more ridiculous than the folly that would undertake to guarantee peace by treaty, and give a world-court authority over the nations without an obedient force, big enough to transmute that court into the most stupendous grafting oligarchy that the world has ever seen. When capitalists and college presidents and politicians of international fame give vent to such puerile notions we may be excused for an economic juvenility of our own, because, even if the realization linger down the centuries, the old system of tariffs and guns and artificial centres of trade and manufacture will keep us from the perils that a scientific basis of economic peace might involve if applied suddenly as a cure for the madness of nations. It may not come true any more than arbitration treaties that will stand, or international courts that will be cheerfully obeyed, will come true; not for years and centuries, perhaps, can this come to pass, and yet it must come true in the end if a man is to advance higher and bring his economic bread-getting existence up to a par with his intellectual conceptions of morality and right.

We are in the economic bronze age! Only copper is free—copper alone of the ordinary articles of commerce. It is strange when we reflect how other industries have been coddled, while copper has grown to be one of the dominant factors in trade and exchange, unsustained by tariffs and subventions. The bronze age points the way to the next step in our economic liberation. When shall we advance to the economic iron age, and thence into epochs of more difficult science in the preservation of industry in accordance with the conditions set by nature? Should trade be allowed to grow by a pact between exhausted belligerents and their supporters in the places and along the courses which by nature are favorable, rather than by virtue of stimulative laws sustained by arrogant militarism, then a police force—all the kinks and wrinkles having been smoothed out by experience—would be enough, just as it would be if all men were to be suddenly inflamed with religious zeal to obey an international court and abide by treaties of arbitration as the corner-stone of a world association of altruists.

This may not be taken wholly as a jest. In jesting mood and manner the wholesome truth may be thrown at an autocratic king. So may it be thrown at a too-proud and over-confident people, who may not pause to think how great were the folly of the fury and heroism of the European war if it should bring merely peace—only an empty peace, with the worms of national aggrandizement rolled up in it to consume both the written word and the parchment. This is something to ponder while the guns are booming, so that when the time comes to end the strife the world may have caught inspiration from the bronze age, and may set something else free besides copper; may establish new principles of free commerce, giving hope that the struggle has brought nearer the blessings of an economic peace. X.



DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Why Ship Concentrate?

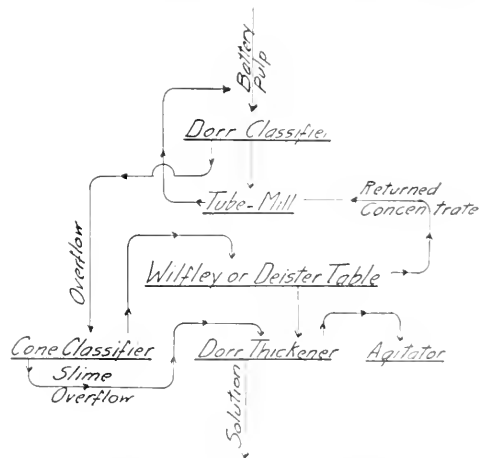
The Editor:

Sir—The question of the local treatment of concentrate, especially in districts remote from railways and smelters, is one that claims the attention of many mining companies. At the present time there are several instances of concentrates being shipped, at heavy expense, although they could undoubtedly be locally treated to greater advantage. In my experience in this country and in other parts of the world there are few places where the raw concentrate is not amenable to treatment by cyanide. It is unlikely that any concentrate presents greater difficulties to successful cyanidation than that produced at some of the Mother Lode mines in California, but it has been shown in recent interesting articles in this paper and by the fact that there are numerous mines on the Lode successfully treating their raw concentrate that such difficulties are not insuperable. The amenability of a concentrate to cyanide treatment having been demonstrated, a possible field is opened up for treatment of the whole ore by similar methods, whereas preliminary roasting does not go beyond the disposal of the concentrate. This fact is of great importance in new mining regions and might affect the future of a district or lead to its more rapid development.

The Waihi mine, which was probably the pioneer in this branch of cyanidation has maintained an extraction of 95-96% of both the gold and silver contents of the concentrate over a period of 12 years. At this mine, in New Zealand, the concentrate presents no difficulty of a chemical nature, the chief consideration being extremely fine comminution of the particles and sufficient length of time of agitation to dissolve the silver content, which is high in proportion to the gold. At Atlanta, in Idaho, a concentrate is produced carrying 4% arsenic, besides antimony, lead, zinc, etc., in less quantities. In this instance serious difficulties were faced in starting cyaniding operations, but the raw concentrate is now being treated profitably. Success in this case hinged upon the fact that freight-charges to the nearest railway-point were excessively high, thus allowing a considerable margin for cost of treatment. Each concentrate presents its own particular problem, which may not be altogether a metallurgical one. Local conditions may be a deciding factor.

Assuming that the treatment of a concentrate in the raw state is a commercially sound proposition, the question next arising is the best method of dealing with it.

It is generally assumed that separate treatment of the concentrate to recover the valuable metals is the necessary procedure. Where the whole ore is cyanided this does not follow. At the Waihi Grand Junction mine, also in New Zealand, a novel system of dealing with the concentrate was introduced some years ago by F. C. Brown, the inventor of the Pachuca tank, and is still in successful operation at that mine. Various articles have been published dealing with this system (some of which are mentioned at the end of this article), but in my opinion it has not been given the consideration that it deserves by metallurgists in this country. Briefly stated, the system consists in placing the concentrating machines in circuit with the tube-mill and making use of them not to recover the concentrate but as an aid to finer reduction.



FLOW-SHEET OF THE WAIHI GRAND JUNCTION MILL.

The machines are placed in position to receive the overflow pulp from the tube-mill classifier. It is advisable in most cases to have intermediate cone-classifiers for the purpose of separating the bulk of solution or water and fine slime, thus avoiding overloading the concentrating machines with slime. The concentrate, together with what would usually be called 'seconds,' or just as much of this material as may be considered desirable, is collected in a common launder and elevated back to the tube-mill feed. In this way the coarser concentrate, together with the larger grains of sand, is repeatedly returned and re-ground until the concentrate is sufficiently fine to float off with the ore instead of settling on the

table. It then passes on, concentrate and pulp being treated together as one product. The essential features of the system are shown in the accompanying flow-diagram.

Separate treatment of concentrate makes crushing and concentrating in water compulsory, while the combination treatment can be carried out either in water or cyanide solution. Crushing in cyanide solution is usually the better practice for reasons well known to metallurgists and mill-men. It is certainly advantageous to carry out the operations of concentrating and grinding in cyanide solution, one advantage having a direct bearing on the system being that the strength of the cyanide solution can be kept as high as is necessary in order to attain the maximum extraction without undue loss in the form of waste solution.

The number of concentrating machines required is somewhat larger than would be ordinarily used on any given tonnage of ore crushed in proportion to the larger tonnage passing in the tube-mill circuit. The Wilfley or Deister type is the best for the purpose, as the concentrate can be more conveniently collected and continuously returned than in the case of machines of the Frue or Johnson type.

Some of the advantages of this system are obvious: (1) The process of treatment is simplified, there being only one product to handle instead of two, thereby reducing cost of operation. (2) Saving in first cost of installation of separate plant. (3) Improved metallurgical efficiency. The system results in an equal, if not higher, extraction at a less cost for cyanide and other chemicals and a more rapid dissolution of the gold and silver content than when separately treated.

The improved metallurgical efficiency is accounted for by the finer reduction of the concentrate, due to the abrasive action of the sand on the softer particles of concentrate and the fact that the particles of concentrate are separated one from another by sand, and thus kept from packing; also the high ratio of cyanide solution to concentrate. That the gold and silver content is brought into solution much more rapidly has been clearly shown at the Waibi Grand Junction. At this mine 80% of the total bullion content in the ore is in solution before the pulp leaves the concentrating tables, and 21 hours' agitation suffices to complete the treatment, whereas 8 to 10 days was previously required when treating separately. The decreased consumption in cyanide is brought about by reason of the fact that the use of a low-strength solution is made possible. The solution circulating in the mill where the system was first adopted is only 0.07% KCN and the extraction 90.9%.

It is not suggested that the system can be applied to ores indiscriminately, although the cases where it cannot be applied are few, outside ores and concentrates not amenable to cyanide treatment. If prolonged contact of the concentrate with cyanide solution is required, it becomes inadvisable to hold back the ordinary slime-treatment in order to extract metal from the concentrate, but due consideration must be given to the fact that a more

rapid dissolution of the bullion-content ensues than when separately treated. Where a tube-mill and classifier operate in closed circuit the heavier mineralized portion of the ore receives preferential treatment owing to its higher specific gravity, and in some instances the concentrate in the pulp coming from the classifier-overflow may be sufficiently fine to allow an economic extraction of the precious metals. As a rule, however, it is necessary to reduce the concentrate to a much finer condition, even to an impalpable slime, necessitating the use of concentrating machines as already described.

At mines where the method of treatment consists of amalgamation followed by concentration without fine-grinding or cyanidation of the whole ore, it follows that the concentrate must be treated separately or shipped to smelters, but it is a problem worthy of consideration by companies that may contemplate treating their concentrate, or that are at present doing so, whether it would not be worth while to go a step further and treat the whole of their ore by some such system as the one outlined. Where no further treatment of the ore follows concentration, the mineral escaping into the tailing is so much profit lost; and even if concentration is viewed as a fine art, it is still subject to inefficiency of machines and the vagaries of the personal equation. In cases where cyanidation of the whole ore follows concentration and the concentrate is shipped, argument in favor of a combined treatment would appear to be even stronger.

The above sketch of an exceptional procedure in connection with the treatment of gold and silver ores is brought forward because it undoubtedly has metallurgical merit and is being applied, in at least one instance, with marked success. So far as I am aware, it has not been applied in this country, but there must be many localities where it could be adopted successfully.*

WILLIAM MACDONALD.

Berkeley, June 5.

Mucking as an Educator

The Editor:

Sir—Being one of those who 'muck' during the summer vacation of the university, in order to gain experience and to accumulate some measure of filthy lucre, I would like to contribute a little first-hand experience, the gaining of which greatly increased my capacity for galgenhumor. I obtained my job by applying to the manager of a mining company whose product is quoted at twice its normal value since the War, and received the answer that they could make use of me if I were willing to work as a common laborer.

*The following articles and papers have appeared on this subject:

'Notes on Cyanide Treatment of Concentrate,' by A. Grothe. Proceedings of Mexican Institute of Mining & Metallurgy, August 1909.

'Cyanidation of Concentrate,' by F. C. Brown, M. & S. P., August 27, 1910.

'Fine Grinding,' by H. S. Denny. *Mining Magazine*, March 1911.

The first week I lived at the company's boarding-house, paying 75 cents per day for the privilege of sleeping in my own blankets on the springs of a bedstead, the mattress being supplied in theory only, as were nine-tenths of the panes in the window.

The place where I worked was a stiff 50 minutes walk from the boarding-house. My job was so exacting that I never managed to eat a single piece of bread from my lunch-bucket at one sitting.

Since the boarding-house furnished only three (mediocre) meals per day, and as I was required to work on night or graveyard shift exclusively, I seldom managed to get more than two meals per day (one of them a cold lunch I took along), which did not deter the company from collecting the full board-money each day. I then moved into a cabin, located nearer the place of my work, and 'batched' for myself, groceries, etc., being obtainable at the company store at the company's prices.

Near the boarding-house there was one shower-bath, which had hot water only when the oil-engines broke down and steam had to be substituted. At the camp where my cabin was, there was no shower-bath until I made one from an old tin-can and some pipe-fittings. This transformed my cabin into a public bath-room despite the assertion "Oh, if I build a shower up there you'd be the only one to use it."

It became necessary, in the course of human events, to lay a pipe-line through verdant growths of 'poison oak.' Seeing us covered from head to foot with the loathsome eezema, the manager facetiously remarked that we should have taken a salt-bath before starting in, the irony of which is apparent, there being no bath-tub within miles of the place. Then it was pompously announced that there was medicine for us "down at the office" and I was detailed to get it. It consisted of a 12-oz. can, half-full of carbolated ointment, which is painfully useless as applied to poison oak. This was distributed among five men and each man was charged \$1.75 for "doctor's treatment!" Considering the fact that I was only getting \$1.75 per day, and that none of us used the stuff, and that we never saw a doctor, and that it wasn't our fault that we had the malady, we felt considerably outraged.

Such privys as were on the place were a flagrant menace to public health, and were seldom, if ever, used.

The lone amusement, or diversion, of the place was a home-talent band, whose every effort lapsed into the familiar strains of 'Home Sweet Home,' no matter what they played.

The ambition of most men seemed to be to get out of the company's debt, and 'beat it.' To a single man this was practicable, but to a man with wife and children it meant a long struggle and privation, in addition to exposing his family to the prevalent unsanitary conditions. Other things that I heard on good authority and without solicitation convince me that if an employee of that company were to barter his soul to the devil, the company would receive a rake-off on the transaction.

Compared with Goldfield and other camps in which I

have 'mucked' and 'bohunked,' working in this camp can only be expressed by the ancient phrase *damnati ad metalla*.

It may not be necessary "for an engineer to have thumped a drill or shoved a car in order to detect whether the one kind of work or the other is being done properly," but I doubt if an engineer can gain a true understanding of the effect that good or bad treatment and living conditions have on a man's attitude toward his work, unless he has worked under favorable and unfavorable conditions himself.

CURT N. SCHUETTE.

Somewhere in the West, June 26.

Uraninite in Colorado

The Editor:

Sir—In response to your request for information concerning my discovery of pitchblende in Gilpin county, 45 years ago, I send you a copy of a short paper of mine which appeared in the Proceedings of the Colorado Scientific Society (Vol. V, page 156), which gives the true story of my discovery of uraninite in Gilpin county, Colorado, in 1871, as described by me in 1895.

The clipping from the Montana paper, you will see, is incorrect. The discovery was made in the Wood lode, and a lease for working was obtained some two years before I became associated with Prof. Hill at Black Hawk.

It may be of interest to record a peculiar feature connected with the deposit of mixed minerals, pyrite and chalcopyrite. My paper was written long before the discovery of radium or the radio-active properties of pitchblende. In the concentration of the mineral for the separation of the pyritic minerals associated with the pitchblende, I noticed that the copper pyrite was blackened on the surface; it had the appearance of being 'powder-smoked.' The black stain, however, was only skin-deep, for a fresh fracture showed the brilliant yellow characteristic of copper pyrite. I was at a loss to account for this strange appearance at the time, but when the wonderful radio-active properties became known, I had no hesitation in assuming that the black deposit was due to radio-active forces.

From the fact of there being such a large deposit of pitchblende covering a comparatively small area, the adjoining rocks would, in all probability show, on examination, indications of the alteration of uranium with its ultimate product helium. It has occurred to me that samples might be taken by sinking into the rock, some distance below the surface, or better still, by driving a small cross-cut into the country-rock each side, north and south. These samples need not be large; blocks about one pound in weight would be quite sufficient, being carefully labeled and making the distance from the deposit.

Professors Joly, Rutherford, and Strutt, who have given a great deal of attention to the subject, might be glad of the opportunity of investigating a matter of such great interest at this time.

It is difficult to arrive at even an approximate figure as to the quantity of pitchblende already extracted from the Wood lode. My own figures, which cover the amount extracted under my lease in the year 1872, would represent, in round numbers, three tons of 60% U_3O_8 . Later, in 1904, I purchased some ore from other lessees, which would perhaps represent altogether two tons more. Since the shaft, in which the discovery was made, was sunk clear through the thickest part of the vertical lens-shaped deposit, the quantity of material sent to the stamp-mills and smelting-works at Black Hawk to determine its value could not have been much less than another three tons of 60% stuff. What has been done since, I do not know, but if we add still another two tons for later discoveries, we have a total to date of, say, 10 tons of concentrated material of about 60% U_3O_8 .

The presence of such a large quantity of pitchblende must have had great influence on the adjoining rocks, and one might expect to find strong indications of helium as a result of radio-activity produced on a large scale.

RICHARD PEARCE.

Liverpool, May 28.

The Occurrence of Uraninite in Colorado

By Richard Pearce

*This rare and interesting mineral was first discovered in Colorado by me in August, 1871, and occurred in what is called the Wood lode in Leavenworth gulch, Gilpin county, about one and one-half miles from Central City, and not at Black Hawk, the locality given in Dana's 'System of Mineralogy.' As the discovery was made nearly 21 years ago, it may prove of interest to the members of this society to have recorded a few details regarding its discovery, and the peculiar conditions under which it was found.

In the summer of 1871 my attention was directed to a group of mines in Leavenworth gulch, owned by the Rochdale Mining Co., and in the course of my examination of one of the several claims belonging to this company, I found on the dump of the Wood claim a heavy black mineral which proved to be uraninite coated with a beautiful canary-yellow material, uranium vitriol, a basic sulphate of uranium formed from the oxide by lengthened exposure on the surface.

The mine had been worked for gold some years previous to 1871, and a considerable quantity of ore was mined and sent to the mill, and, it is believed, to the smelter, but the results were not satisfactory, and the mine was abandoned. The agent of the company stated that the mill men objected to the ore on account of its high specific gravity, as it hung most tenaciously to the

plates and scoured the amalgam; he also stated that a load of the ore was sent to the smelter to be tested, and, after sampling and assaying, it was found to contain no gold, pronounced worthless, and thrown into the creek.

The discovery of uraninite thrown broadcast, on an old dump, was a source of astonishment to me, for I had been accustomed to see it only in very small quantities, and under peculiar geological conditions. At first I could hardly venture to trust my own opinion; and a blowpipe apparatus, the property of an old Freiberg friend, being found at one of the mills close-by, in Russell gulch, a quick test proved the existence of uraninite, or 'pitchblende,' as it was commonly called.

About 200 pounds weight of the mineral was sorted out of the dump and sent to me, at Swansea (Colorado). There it was still further selected and sold to the firm of Johnson & Matthey, London, for the sum of £42, or \$210.

The rock in which the Wood lode occurs is mica-schist traversed by veins of feldspar and quartz enclosing magnetite, and the lode, which had been explored only to the depth of about 60 ft., was said to be four feet in width with six inches of solid uraninite. The associated minerals, as seen on the surface, were pyrite, chalcopyrite, with small quantities of pyrrhotite and galenite, the gangue being mainly quartz.

A lease of the property was obtained in the following year, and the mine was re-opened and worked for uranium. It was found that the shaft had been sunk through the centre of a vertical lenticular deposit of uraninite, and, consequently, the richest and by far the largest bulk of the ore had been lost through ignorance of its value. That portion, however, which was left, was extracted, and, after careful sorting, about 3 tons of rich ore, containing about 60% of pure black oxide of uranium, was shipped to London where it realized about \$7500.

History repeats itself. In 1894, twenty-three years later, the mine was again opened and worked on lease, and in driving west from the old shaft at a greater depth, another lenticular deposit of uraninite was encountered; but as the nature of the mineral was unknown to the people who had the lease, the same disappointment from the mill-returns was experienced as in the first discovery. A specimen of the ore was brought to me by the lessee, who had heard from some source that I had found something rare and valuable in the Wood lode many years before. The new find proved to be uraninite of exactly similar character as the first deposit found in 1871. I purchased a quantity of the ore, but have not as yet been able to find a satisfactory market for it.

The mineral uraninite formed the subject of some highly interesting investigations by a former president of this society, Dr. W. F. Hillebrand, who pointed out, for the first time, that it contained the element nitrogen. More recently Prof. Ramsey has discovered that the large bulk of the gas thought to be nitrogen by Dr. Hillebrand, proves to be the new element helium.

*Proceedings of Colorado Scientific Society, Vol. V, 1895, being the article mentioned in the preceding discussion by the same author.

The Motor-Truck in Arizona

By Wilbert G. McBride

TWO Alco 3½-ton motor-trucks were used by Young Bros. while operating at the Mammoth Collins mine at Shultz, Arizona. One was equipped with an oil-tank holding 1075 gal. and was used for the transportation of 'tops.' The other was fitted with a stake body and used to carry machinery, wood, rails, pipe, and all classes of miscellaneous supplies. The bodies were made of oak with maple flooring and were attached to the frame of the chassis by U-bolts, to avoid drilling the main members of the frame.

Most of the hauling was done from Tucson, a distance of 47½ miles. During the first three months, part of the road was in bad condition and the tire cost was excessive. After this part was repaired, the road was in fair condition, but never good. There were no excessive grades or bad sand, but wagon-ruts, too narrow for the truck-wheels and of a different gage, caused heavy tire loss; while chuck-holes, sharp curves, and stones, both imbedded and loose, were objectionable features. During wet weather the trucks could not get sufficient traction to climb some of the hills and were likely to stick in the mud, so that no attempt was made to run them unless they were on the road when the rain started. This lost time amounted to about 5% of the total, but, whenever possible, it was utilized in making minor repairs.

The price of gasoline was from 17 to 21c. per gal. Rubber tires were used throughout. Drivers were paid \$4.50 to \$5 per shift, and a return trip to Tucson was counted as two shifts even when made in one day. Drivers were provided with a room in Tucson and were paid for all time lost due to causes beyond their control. Trucks were loaded one way only.

Speedometers were placed on both trucks, but the excessive vibration soon caused them to fail. For this reason, and because no account was taken of the distance covered in picking up a miscellaneous load or in other minor ways, the mileage given is under the actual distance traveled. Some of the weights had to be estimated, but care was taken to have the number of ton-miles low rather than high, to avoid under-estimating the costs. The cost of hauling from Tucson to the mines was \$12 per ton with the trucks, while the best possible team price was \$15. Teams made one return trip a week, while the truck regularly made one in two days and could always, and many times did, do it in one day. The loss of time due to wet weather would be about half as much with teams as with trucks.

The table of detailed costs given below covered the period from August 21, 1913, to August 15, 1914, the

only time in which the trucks were continuously employed. From August 15, 1914, to March 30, 1916, the trucks were used intermittently, but the figures for this period have been excluded as not being representative. If included, they would lower the cost per ton-mile. Just prior to the close of the period covered by the figures, the trucks were overhauled and put in good condition; new rear-wheels were put on and new tires substituted. The cost of all this was charged to operation. Allowances for extra tires on hand would reduce the cost per ton-mile approximately 3c., leaving a net cost of about 25c. With loads on the return-trip this cost per ton-mile would be lowered at least 40%.

OPERATING DATA

Total distance traveled by trucks	23,000 miles
Total work done by trucks	42,700 ton-miles
Average distance covered per gallon of gasoline	4.5 miles
Average distance covered per gallon of lubricating oil	128 miles
Average speed, loaded	7 miles per hour
Average speed, light	7.8 miles per hour

DETAILS OF COST

	Total cost	Per cent of total	Per truck-mile	Per ton-mile
Wages of drivers	\$2,623.32	23.91	\$0.1141	\$0.0614
Wages of helpers	286.50	2.62	0.0125	0.0067
Repairs, labor	581.74	5.30	0.0253	0.0136
Repairs, lost time	156.15	1.42	0.0068	0.0037
Oils, grease, and waste	379.17	3.46	0.0165	0.0089
Gasoline	1,619.49	14.68	0.0700	0.0377
Tires	2,415.75	22.30	0.1063	0.0573
New parts	515.08	4.69	0.0224	0.0121
Miscellaneous supplies	348.82	3.18	0.0152	0.0082
Incidental expense	226.21	2.06	0.0098	0.0053
Depreciation	1,796.80	16.38	0.0781	0.0421
Total	\$10,970.03	100.00	\$0.4770	\$0.2570

The advantage of the motor-truck over the team and wagon are many—increased speed, ability to work 24 hours per day when necessary, and lower cost on long hauls—but its adoption by the mining industry has been slow. Where trucks are used around mines they are usually driven by cheap inexperienced men, the upkeep and repairs being turned over to the regular mine mechanics. It would be equally good practice to employ a timber-framer to make a dining-room table. Just as the niceties of cabinet-making are unknown to the timber framer, the exact adjustments and fine workmanship of the high-speed engine and transmission-gears of a motor-truck are beyond the ken of the mine mechanic, one of the least skilled of his class. If there are enough motor-vehicles at the mine, the master mechanic probably turns the work over to one or two men who, in time, become in-

*A paper to be read before the Arizona (September 1916) meeting of the American Institute of Mining Engineers.

different auto-mechanics, but in the meantime the cost of maintenance soars and often the trucks are condemned. The aim of the makers of all motor-vehicles is to secure the maximum of strength and power with a minimum of weight and size. To do this, high-speed engines, the best of materials, and the finest of workmanship are employed, and parts are reduced to the least possible weight consistent with strength and durability. This is just the reverse of the ordinary American mechanical practice, in which reliability is secured by slow speed and large size, the amount of material used and the space occupied being minor considerations. It is, therefore, unreasonable to expect the mechanic trained in one school to understand immediately and adapt himself to the ways of the other. It must also be remembered that no other machine is given the hard use and necessary abuse that motor-trucks receive. The vibration while on the road will loosen nuts and rivets, and this, if not attended to in time, will cause serious trouble. Where only one or two trucks are used, the drivers should be competent mechanics and should be held responsible for the maintenance of their machines. Where several are used, they should be under the direct supervision of a thorough truck-mechanic that is held responsible for operation and given entire control of the drivers and repair-work. His constant care will detect and remedy many incipient defects and prevent expensive and annoying break-downs. With the exception of the time required for periodic overhauling, he should be able to keep the trucks in almost continuous service. This will make possible the employment of cheaper drivers without undue damage to the machines.

Motor-trucks should not be installed without careful consideration of the roads to be traveled. The difference between the cost of motor-truck and team-hauling is largely controlled by the quality of the road, and on really bad roads the motor-truck is decidedly the more expensive. Many roads are fatal to truck-haulage, and considerable experience is required to decide this question without an actual test of some duration. Excessive grades are to be avoided, especially long ones. The ordinary truck will pull over a short 20% grade with ease, but will give great trouble on a long one of half that rise unless special cooling arrangements are made. Grades greatly increase the tire and gasoline consumption and decrease the life of the machine. Rocky roads, particularly when the rocks are sharp or loose, are hard on tires. Deep sand is difficult to cross, and for this class of road the caterpillar tractor and the four-wheel-drive truck have distinct advantages. Trucks that drive on the rear wheels only cannot operate in heavy sand. Narrow or rutted roads are objectionable for the larger-sized trucks because they throw all the weight on one of the rear dual tires from time to time, and this over-loading is injurious to the rubber. Fairly deep streams can be crossed, but mud is an absolute barrier except to the caterpillar type of tractor. Few dirt-roads will stand up under a 7-ton truck, but those of 4 tons, or under, do less damage than the ordinary freight-wagon.

Unfortunately, trucks are not designed to suit mining conditions. At Shultz we found it necessary to cut down the gear ratio, increase the size of the wheels and tires, and add bumper or auxiliary springs. Had the grades been steeper it would have been necessary to increase the cooling capacity.

For long hauls the motor-tractor will probably replace the motor-truck. It will operate at a lower cost because the load will be carried on iron tires, and, as the table of detailed cost shows, the rubber tires account for 22.3% of the total. Tractors travel more slowly than motor-trucks, but the tonnage hauled on a trip is much greater. They are also easier on roads, as the load is distributed over several trailers. By using extra trailers, loading and unloading can be done on the road.

The make of a truck is not as important as the care it receives. Almost any standard make will do good work if given careful attention, but none will be satisfactory if not well cared for. Economy should not be sought in the lubricants used; the best oil is none too good. Overloading should be scrupulously avoided. A truck may be made to carry many times its rated load without breaking down, but the damage is none the less real because not immediately apparent. High speed, particularly if the road is rough, should be avoided, since it subjects the machine to excessive strain and vibration. Most trucks are now equipped with speed-governors, but these are easily tampered with and must be carefully watched. When they are not used, the drivers should be carefully instructed as to the speed-limits and compelled to respect them.

Distillate and 'tops' are now successfully used on trucks, by the application of a special carburetor. The use of these should effect a material saving in the gasoline cost, which now amounts to almost 15% of the total. 'Tops' usually sells for 30 to 35% and distillate for 50 to 60% of the price of gasoline. With a properly designed carburetor, the available power in the lower-grade fuel will be about the same as in the gasoline, but the carbon deposition will probably be somewhat greater.

SHOVELING of broken rock underground in the lead mines of south-eastern Missouri averages 18 tons per man per shift. The shovels used are long-handled round-pointed No. 2 type, requiring about 130 shovelfuls to fill a ton car, or a load of 15 lb. per shovel. The cost of shoveling averages 13c. per ton. Short D-handled shovels, such as are used in the mines of the Lake Superior region, are not liked in the lead mines. The advocates of the short shovel claim that a man can make more and faster motions with the shorter tool than with the long-handled shovel, and can turn around more quickly in a narrow drift. But, it is argued in answer to this, the amount of rock that a man will shovel in a day is not measured by the fast motions that he can make while the boss is looking, but by the continued strain on his back. The long-handled shovel scatters the muscular effort over the body, taking some of the burden from the back and placing it on the legs.

The Flotation of Minerals

By Robert J. Anderson

*Many phenomena are supposed to contribute to the flotation of minerals, whether in whole or in part is a mooted question. I shall only sketch roughly the present tendency of ideas and make no reference to the first early and crude notions, which are now mainly of historical interest.

SURFACE TENSION has been well defined in articles appearing in the *Journal of the American Chemical Society* during the years from 1908 to 1913. The theory has been treated in particular by Laplace, Gaus, and more recently by Van der Waals, and by Willows and Hatschek.¹ As defined by Jones,² "potential energy, present at the surface of liquids, produces a tension which is known as surface tension." The phenomena invariably indicative of surface tension are: Drops of a liquid not exposed to an external force, that is, either suspended in another liquid of the same specific gravity or freely falling, assume a spherical shape, the sphere being that form of body with the smallest surface per given volume; further, if water be placed in an open vessel its surface film will be a measurable quantity, and its thickness will vary with a number of factors of which temperature is one. Its thickness is observed as ranging from 4×10^{-5} cm. to 4×10^{-6} cm., and its density, when referred to the main bulk of the water below, will approximate 2.14. Surface tension is not affected by the surface area. It is numerical in value and expressed in dynes per centimetre. It is a variable factor dependent on temperature, increasing numerically with falling temperature, for example, water at 18° C. has a surface tension of 73 dynes per centimetre, and at 0° C. this increases to 75 dynes. At the critical temperature of a liquid its surface tension becomes nil.

All liquids have a definite cohesion or tensile strength, which is ascribed to the mutual attraction of their molecules. This then is comparable to a pressure existing within a liquid, which has been termed the 'intrinsic' pressure. Naturally the value of the surface tension of solids is numerically high. The surface tension of a pure liquid against its vapor is markedly affected by the addition of soluble contaminants. Some salts will raise the surface tension of water while others will lower it; the fact that the salts of weak acids will lower the surface tension of water is explained by the fact that free acid is liberated by hydrolysis. It is further known that all acids will lower the surface tension of water, which is

also decreased by the addition of oil, or, in other words, oil will reduce the interfacial tension between the water-air phases. A phenomenon for which no explanation has been given is the one showing that the addition of contaminants may either raise or lower the surface tension of water, but such addition, while it may decrease that tension greatly, can increase it only slightly. Any lowering of surface tension is more marked in a liquid that has a high surface tension, such as water, than in liquids of low surface tension.

There can be, of course, no surface tension without adsorption, which produces, in the case of positive adsorption, an increased surface concentration resulting from a lowering of the surface tension by the contaminating and dissolved substance, whatever it may be. The equation of Gibbs ($u = -c/Rt \cdot d\sigma/dc$) gives the relationship between surface tension and the distribution of the solute between the bulk of the liquid and the film interface. Here the notation is:

u = excess of substance in the surface layer,

c = concentration in the main body of the liquid,

R = the gas constant,

t = absolute temperature,

σ = surface tension.

This shows that when the surface tension is reduced by the addition of a contaminant, the quantity du/dc is negative and u is positive (from algebraic consideration). The surface film then contains more of the contaminant than the main body of the solution. If the surface film contains less of the contaminant than the main body of the solution it is a case of negative adsorption.

As given in the foregoing, the surface of a liquid against its vapor is in tension; the surface of liquid against another liquid, or a gas or solid, is also in a state of tension; this is termed 'interfacial.' In the flotation machine the following conditions obtain: Pulp consisting of ore of approximately 80-mesh, water in ratio of 3:1 of ore, and oil in disappearingly small amount, is being violently agitated. For the sake of a specific case, the air is being forced mechanically into the swirling pulp by beaters or stirrers. The phases present in flotation by the oil-froth process are therefore: solid-liquid (ore-water), solid-liquid (ore-oil), solid-gas (ore-air), liquid-liquid (water-oil), liquid-gas (water-air), and liquid-gas (oil-air). Thus six tensions are present, but if the oil is soluble in the water the tensions are reduced to three. It is known that pure water cannot be made to maintain a persistent froth because its surface tension is too high. Acid, if present, will lower the surface tension of water, as will oil, if it is soluble.

Certain metallic sulphides, such as galena, have the

*Abstract of paper to be read at the forthcoming Arizona (September 1916) meeting of the American Institute of Mining Engineers.

¹Willows and Hatschek: 'Surface Tension and Surface Energy,' 1915.

²Jones: 'Elements of Physical Chemistry,' 1907.

power of floating on undisturbed water; they are not wetted and the curve of contact is convex. Some gangue minerals, such as quartz, possess an adhesive force of attraction for water that exceeds the intrinsic pressure of the water; they are therefore wetted and sink to the bottom, being drawn through the surface film. Such properties of the minerals are affected by the presence of oil, acid, and other reagents. Oil has a greater adhesive attraction for sulphide minerals than for gangue minerals; and the addition of acid and oil (if it is soluble) acts as a contaminant that will lower the surface tension of the water and aid in the production of a persistent froth. Let us now look into the question of adsorption and see what part it plays in flotation, since it is so requisite to the production of a variable surface tension.

Adsorption. Generally speaking, adsorption deals with the unequal distribution of substances at the interface between dissimilar phases such as, solid-solid, solid-liquid, solid-gas, liquid-liquid, liquid-gas, and gas-gas. It is purely a physical effect. Commonly, adsorption⁵ is construed to be the result of the condensation of a disperse phase upon the interfacial boundary solid-liquid. Returning for a moment to the Gibbs equation quoted above, adsorption may occur if the interfacial tension solid-liquid is reduced, this being positive adsorption. If, however, such an interfacial tension is raised in value it is a case of negative adsorption, as the solute or disperse phase will be rejected from the surface. Any condensation, strictly stated, of a solute or disperse phase in the interfacial boundary separating liquid-liquid or liquid-vapor is held to be a special case of adsorption. However, in the general sense, the phenomenon is looked upon as being the result of condensation of a disperse phase in the interface of two immiscible phases. Adsorption is shown strikingly by colloid gels—the product obtained by the coagulation of sols—and certain cases of selective adsorption are most remarkable. Adsorption will naturally vary with the surface exposed. In Miss Benson's experiments with amyl alcohol in aqueous solution, amyl alcohol reduced the surface tension of the water, and it was found by producing a voluminous froth that the alcoholic concentration in the froth exceeded that in the bulk of the aqueous solution by about 5%. A froth has a very large surface, and it would be expected that the adsorption would be greater. Such experiments prove the value, qualitatively, of the Gibbs rule.

Recent work shows that all solids do condense gases on their surfaces and retain them there with great tenacity. Liquids in like manner adsorb gases. Further, liquids and solids exhibit selective adsorption of gases. Although this selective adsorption obtains, no proof has been submitted indicating that the amount of gas adsorbed by one substance is largely different than the amount adsorbed by another substance. An electric charge on an adsorbed substance probably would influence the amount adsorbed. The adsorption of air

plays an important role in flotation, for as Breuer points out, the adsorbed air film is enormously responsible in preventing the coalescence of solid particles.

A comprehensive study of the adhesion of small particles of solid to the dineric interface (surface separating two liquid phases) has been made by Hofmann⁴ based on the theory of Des Coudres.³ From the standpoint of flotation this may be given as follows: If a solid particle, such as quartz, is wetted much more strongly by water than by another liquid, such as oil, the water will displace the oil, and a film of water will form about the quartz particle according to the relative forces of adhesion. Then the quartz particles will remain in the water phase if the water has a specific gravity greater than the oil, regardless of their size; but if now the oil has a greater specific gravity than the water, then the quartz particles will remain in the water phase until the size of the particles is such that the force of gravity will remove them from the water. Conversely, if a solid particle, such as galena, is wetted more strongly by oil than by water, the oil will form a surface film about the particle and hence prohibit the particle from being wetted by water, that is, from entering the water phase. Then the galena will only enter the water phase when the water is more dense than the oil, and, further, when the galena particles are of such a size that the force of gravity overcomes the adhesion of the oil film to the oil.

Returning to purely theoretical considerations, Hofmann draws certain conclusions that deal with the supposition that solid particles will then remain in the surface separating two immiscible liquids, if these particles are wetted partly by each liquid. I quote Bancroft at length on this matter.⁶ "The solid particles tend to go into the water phase if they adsorb water to the practical exclusion of the other liquid; they tend to go into the other liquid phase if they tend to adsorb the other liquid to the practical exclusion of the water; while the particles tend to go into the dineric interface in case the adsorption of the two liquids is sufficiently intense to increase the miscibility of the two liquids very considerably at the surface between solid and liquid."

Any simultaneous adsorption of two immiscible liquids by a solid would tend to form a homogenous liquid phase at the surface of the solid.

In regard to the effect of contaminants or other impurities in contact with two immiscible liquids, this condition obtains: If the contaminant is soluble in one liquid but not in the other, and also lowers the interfacial tension of the two, the equation set forth by Gibbs exacts the requirement that the contaminant should obtain in the interface. Examples of this prove the validity of the law.

The terms adsorption and absorption have been used interchangeably in some writings, thus contributing to the already existing confusion of ideas.

³*Zeit. Phys. Chem.*, Vol. LXXXIII, p. 385, 1913.

⁴*Arch. Entwicklungsmechanik*, Vol. VII, p. 325, 1908.

⁵Bancroft: *Journal of Physical Chemistry*, Vol. XIX, No. 4, p. 287, (April 1915).

⁶Bridge: *Journal of Physical Chemistry*, Vol. XIX, No. 3, p. 157, (March 1915).

Absorption or Occlusion. There are three ways by which gases can be held with reference to solids: (1) By surface adsorption; (2) in solid solution; and, (3) by occlusion. The term 'occlusion' has been applied indiscriminately to any of these methods by which gases are held by solids. Strictly speaking, by 'occluded' gas is meant gas that is absorbed and held in finely-divided pores or openings, which may be of microscopic size. A recent theory¹ holds that occlusion plays the operative role in the flotation of minerals by all processes. I am unable to reconcile myself to this explanation, for a number of reasons. Marked instances of occlusion at normal temperature are known only in certain amorphous substances, like charcoal. Many metals, of course, both in the liquid and solid states, have the power of occluding gases, often in marked degree. There may be and undoubtedly are fine pores in the floatable minerals, which may in a sense be considered as an assemblage of capillary tubes; these can and do occlude gas. Yet occlusion is marked only in amorphous substances and in certain metals as just stated. It is definitely known that occluded gases are retained with great tenacity by the substances occluding them and therefore are expelled only with difficulty. It seems anomalous to hold that the occluded gas can depart from the mineral occluding it with sufficient speed to aid the air bubbles in the liquid in the process of flotation. I believe firmly that occlusion is not a cogent factor in flotation, and that a more consistent theory may be formulated without postulating these conjectures regarding occlusion.

Colloids. In the original definition of the term by Thomas Graham, do not constitute a definite class of substances; a large number of different substances may be made to assume the colloidal state if proper precautions are taken. All of which reveals the striking fact that this colloidal condition is a *state* and not a *form* of matter. The ultra-microscope of R. Zsigmondy and H. Siedentopf has greatly increased our knowledge of colloids. A general statement may be made regarding colloids; that they do not show osmotic pressure in appreciable amount. Colloidal solutions—sols—are regarded as systems of two phases, in which the dissolved substance is the disperse phase and the solvent the continuous phase.

Since, in flotation, the ore is often as small in size as certain of the colloids, the pulp (ore, water, etc.) can be looked upon as a coarse suspension, and the laws of colloids apply here with equal force as in the realm of colloidal chemistry. So-called suspensions are systems consisting of solid particles of microscopic size distributed through a liquid. As mentioned by Ralston, Reinders has treated at length the particular case of a solid phase maintained in contact with two liquid phases, that is, two immiscible liquids. His work is based on the different

interfacial tensions existing, and his experiments and those of Hofmann, as mentioned in an earlier paragraph, have considerable bearing on the flotation problem.

Emulsions are fairly coarse dispersions of one liquid in another with which it is immiscible. The simplest and commonest emulsions are the pure oil-water emulsions, containing no emulsifying agent such as soap, proteins, etc. In such systems the oil globules can be coagulated by electrolytes, they show the Brownian movement strikingly, and can even be retained by some filtering media. Any process of emulsification is dependent on a lowering of surface tension, or, to be more precise, on a lowering of the interfacial tension between the two phases. According to Briggs and Schmidt, the two essential requirements of an emulsifying agent are: (1) The property of condensing by adsorption in the dineric interface; and (2) the ability to form under these circumstances a strong coherent film. Temperature is a decisive factor in emulsification, for its effect is to reduce the interfacial tension between phases and also to lower the viscosity of the phases. In the production of emulsions, a considerable amount of surface energy is produced because of the relatively large surface area of the disperse phase; an emulsion is the more speedily effected if such surface energy be reduced by the use of a liquid having a low surface tension as the continuous phase. Some emulsions, under certain conditions, display a great increase in viscosity over that of either of the immiscible phases, for example, the emulsions of the Pickering order—up to 99% of oil in 1% of soap solution—can be cut into cubes. Any emulsion produced with soap solution is at once destroyed by the addition of acid, as the latter will decompose the soap.

If solid particles are suspended in a liquid, they tend to increase the viscosity of that liquid gradually, depending on the amount of solid particles present. Experiments have shown that whenever a substance in suspension is wetted by two immiscible liquids simultaneously, it will go into the dineric interface in the manner already mentioned, and will tend therefore to produce an emulsion. If, however, the suspended particles cannot coalesce, owing to adsorbed oil film or for other reasons, and thus effect the production of a coherent film, the emulsion will not be stable. Few data are available on the production of emulsions by the oils used in flotation work, or on the matter of interfacial tensions between such oils and water. However, we are now dealing with emulsified or partly emulsified pulp in some of the flotation processes, in the oil-froth process at least.

ELECTROLYTIC AND ELECTRO-STATIC PHENOMENA. Any substance placed in contact with water or any other liquids will assume an electric charge, the sign of which is, as yet, not set forth. Most substances when in contact with water become negatively charged, but these charges can be differed at will or reversed by the addition of the proper electrolyte in requisite amount. These electric charges are by no means confined to substances

¹Durell: M. & S. P., Vol. CXI, No. 12, p. 428 (Sept. 18, 1915) and Durell: *Metallurgical and Chemical Engineering*, Vol. XIV, No. 5, p. 251 (March 1, 1916).

²Ralston: M. & S. P., Vol. CXI, No. 17, p. 624 (Oct. 22, 1915).

³Briggs and Schmidt: *Journal of Physical Chemistry*, Vol. XIX, No. 6, p. 479 (June 1915).

scopic particles, but are found also on the particles of a coarse suspension. Gangue minerals, such as quartz, when suspended in water, are negatively charged, and sulphide minerals, such as pyrite, are positively charged under like conditions. Oil drops are negatively charged, as are air bubbles under certain conditions. These charges are very minute when referred to the mass of the particle. Substantial evidence is at hand to show that floatable minerals have the positive sign of electricity when suspended in water or can be made to assume that sign by the addition of proper electrolytes in sufficient amount. As Callow¹⁰ observes, there is a parallelism between electro-static characteristics and the floatative properties of ores. Many of the electro-static principles have either been carried too far or misapplied, as recent work shows.

Experiments in colloid chemistry indicate that the contact films are charged and that such charges affect the dispersion or coherence of the particles in suspension. Of course, oppositely charged contact films will coalesce while similarly charged contact-films will repel each other, if the charges are sufficient in amount to overcome the force of cohesiveness; in the latter, dispersion is the result. The oil and air contact-films having negative charges would tend to attract the sulphide particles, but further than this possibility electro-statics probably plays little part in flotation.

It is generally admitted that only good conductors are suitable to flotation. Now then, as the electrical theory contends, electrified bubbles must be supplied to float the conducting minerals that are attracted, leaving behind those that are not. The bubbles in flotation are simply air spaces contained by a mantle of oil or of water, and there is, therefore, nothing within to bear the charge. In case it could carry a charge, which would only be possible by the presence of contained ionized gases or water-vapor, the charge would be speedily dissipated by contact with the interfacial boundary. Then in order that a bubble may carry a charge it must be protected by a dielectric film. Further, electro-statics plays probably little part in holding the sulphide particles and the gas bubbles together, as neither the bubble nor the particle can have a charge of sufficient magnitude when referred to the size. The electrical theory has been strongly championed by at least one writer¹¹ and has been tolerated by some others. A recent article¹² indicates that the principles of electro-statics have been considerably misapplied. It is my belief that electro-statics may be a small contributing factor in flotation in a manner not as yet understood because of a lack of information concerning charges at the interfacial boundary between immiscible phases, for ex-

ample, where the colloidal state is introduced in oil-water emulsions. Apparently, the electric theory is not important.

FROTH AND BUBBLES. The idea has been abandoned by most people that a low surface tension is the essential requirement for froth formation. As mentioned by Coghill in a recent writing,¹³ the contamination of the liquid with an impurity that will cause a variable surface tension is the real requirement. A bubble of air is spherical in shape and this shape can only be maintained if the external pressure exceeds the internal pressure. Since a bubble does not expand *per se*, large bubbles can only be accounted for by heat, coalescence, or electrification. Viscosity is an important factor in froth-persistence, as it increases the tenacity of the liquid film and thus prevents ready rupture. The rupture or bursting of bubbles is explained thus:

1. Concussion upon a surface film deficient in the requisite viscosity and variable surface tension.
2. Relief of pressure—here the gas of the bubble in expanding exerts a pressure exceeding that of the liquid film.
3. Adhesive force of the entrained gas for the atmospheric air.
4. Evaporation of the liquid film.

Flotation bubbles will burst for any one or a combination of these reasons.

Solutions in which the continuous phase is a solution of soap, various products from the saponification of albumens, etc., will froth voluminously even in a very diluted condition; frothing never occurs in pure liquids and is a definite proof that the solute or disperse phase lowers the surface tension of the solvent. A froth, which shows adsorption at the interfacial boundary of solution and gas, depends for its persistence on the production of a viscous film at that boundary; these viscous films are the direct result of surface adsorption of the disperse phase, that is, dissolved contaminants, the amount of which is small—disappearingly so. The work of Hall and of Miss Benson shows that in a foaming liquid the foam is richer in the dissolved contaminant than is the bulk of the liquid. Froth formation in the Callow cell is the result of the injection of air into the pulp (already emulsified); the froth persists as long as there is sufficient air injected into pulp of the proper consistence. The froth in the Callow cell is governed in nature by the kind of oil used and by the amount of air. A pneumatic froth is unstable or ephemeral; it dies when removed rapidly from the influence of the injected air. The mechanical froth, on the other hand, is thick and persistent, and must be broken up in dewatering the concentrates.

Oils have a selective action for metallic sulphides, tellurides, and some other minerals. The fact that both the oil and the air or other gas have a selective adhesion for sulphides prevents them from being wetted by water. Conversely, the quartz and other minerals exhibit just the opposite characteristics. The gangue-minerals, generally, do not exhibit adhesion for either gas or oil:

¹³ "The Science of a Froth," M. & S. P., February 26, 1916.

¹⁰ J. M. Callow: Bulletin A. I. M. E. No. 108, p. 2312 (December 1915).

¹¹ Bain: "The Electrical Theory of Flotation," M. & S. P., Vol. CXI, No. 22, p. 824 (Nov. 27, 1915) and Bain: "The Electrical Theory of Flotation," 11, *ibid.*, Vol. CXI, No. 24, p. 883 (Dec. 11, 1915).

¹² Fahrenwald: "The Electrostatics of Flotation," *ibid.*, Vol. CXI, No. 11, p. 377 (March 11, 1916).

hence they are readily wetted by water. Gases have a well-defined adhesiveness for oils; therefore the air or gas adheres strongly to the oil film. The stability of a froth depends, in the main, on the kind of oil used, for example, pine-oil makes a weak brittle froth, and creosote makes a stable elastic froth. The work of Devaux¹⁵ on oil films explains how so small an amount of oil as is used in the various flotation processes can be so efficacious. From a consideration of the immiscible oil-water interface, if any oil will film the internal surface of a gas bubble the sulphide particles would be contained in the oil-water interface no matter what the nature of the gas contained by the water film. The sulphide, if it enters the oil phase, would then present an oiled surface to the water phase. There are three conditions then: (1) The mineral enters the oil phase completely; or (2) the mineral enters the water phase completely; or (3) the mineral enters the oil-water interface.

Experiments made to determine the nature of the frothing selective, and collective action of different oils show some interesting results. I made tests on a zinciferous slime from Joplin with different oils, the results obtained indicating that a definite mixture of oils will effect better recoveries than any one oil alone. The best combination consisted of pine-oil as a frother, plus wood-creosote as a frother and selector, plus refined tar-oil as a froth stiffener.

In general, pine-oil makes a brittle froth, which immediately dies; creosotes make a more elastic froth, the bubbles of which may expand to 3 in. diam. or more before rupture. Coal-tar products are poor frothing agents and if used must be aided by either creosote or pine oil to produce a good froth. Oils of a lubricating nature seem to be of little value in flotation, while such light oils as gasoline and naphtha are of value only for thinning the heavy coal and wood tars.

AIR AND GAS. At this time, there are three ways by which a gas may be forced into a solution mechanically as follows:

1. By beating it into the solution by means of paddles, as in the Minerals Separation and similarly mechanically agitated machines.
2. By pneumatic means, as in the Callow cell, where the air is divided by the porous blanket-bottom into minute sprays.
3. By so-called liquid jets, as in a process recently patented in which the air is introduced as a surface film surrounding a liquid jet by surface tension.

Conversely, there are three methods by which dissolved gas may be expelled from a liquid:

1. When the liquid is super-saturated, the excess gas is expelled.
2. By heating the liquid, when some of the gas is expelled owing to an increase in its volume.
3. By pressure reduction, as in the Elmore vacuum process, where, according to the law of Henry,¹⁶ "the

amount of gas dissolved by a liquid is proportional to the pressure to which the gas is subjected."

An air or gas bubble on being introduced into a liquid is at once surrounded by a film of the liquid. Such a bubble will rise to the surface (carrying the metallic sulphides by reason of the forces already mentioned) on account of gravitation, by which is meant that the adherence of the air to the liquid is less than the force of gravity.

RÉSUMÉ. From a consideration of the foregoing, it is believed that the theory based on the different interfacial tensions involved is the dominating one at this time. Probably flotation is due to a combination of complex phenomena. The theory based solely on occlusion goes "by the board," as has been shown that the contributing effect of this phenomenon has been interpreted laxly.¹⁶ The phenomenon of electro-statics may be a small contributing factor, but recent work indicates that the principles have been misapplied. An explanation more in consonance with fact can be given in terms of the interfacial tensions involved, without postulating either occlusion or electro-statics.

The main and essential requirements for froth flotation are: (1) The production of a persistent froth; (2) the attachment of the bubbles of air to the sulphides or other material to be floated; and (3) the maintaining of a selective action by the froth bubbles for the sulphides or other material to be floated.

REDWOOD is the famous big tree of California. Its property of resisting the action of acid and alkaline solutions, oils, insects, and decay in general, has brought it to the attention of miners and mill-men. Nearly 40% of the lumber cut annually in California is redwood; in 1915 redwood furnished 418,824,000 ft. of a total of 1,118,703,000 ft. cut. It belongs to the genus of conifer (or cone-bearer) called *sequoia*, which forms one of the links between the firs and the cypresses. Two species are found in California, the *sequoia sempervirens* of the Coast Ranges, and the *sequoia gigantea* of the Sierra Nevada, the largest of known conifer. The *sempervirens* is the typical redwood of the California woodsmen. It grows to large size, up to 12 ft. diameter and 270 ft. long. The boughs are few and short, and the trunk is straight. The wood is like cedar, it splits evenly, and polishes well. While strong and durable, it is not especially elastic. The tree does not grow in other parts of the United States. The species *sequoia gigantea* is confined to detached localities in the Sierra Nevada, usually at an elevation of 4000 or 5000 ft. A few have attained a height of 400 ft., some are believed to be 3000 years old. They are the remnants of extensive forests belonging to a past epoch. Nowhere else in the world are red woods of large size found.

COPPER production of Russia during 1915 was 29,800 short tons, compared with 36,430 tons in 1914.

¹⁵Devauux: 'Oil Films on Water and on Mercury,' *Smithsonian Report of 1913*, p. 261.

¹⁶Jones: *Elements of Physical Chemistry*, p. 177, 1907.

¹⁶Ralston: 'Why Do Minerals Float?' *M. & S. P.*, Vol. CXI, No. 17, p. 623 (Oct. 23, 1915).

An Earthquake in Nevada

By E. L. Berry

The old mining town of Kennedy, in Humboldt county, is situated in the East Humboldt range, in township 28 north, range 38 east, and is about half-way up the eastern side of the range above Pleasant valley.

On October 2, 1915, at 3:40 p.m. there occurred an earthquake shock of sufficient intensity to be felt plainly by persons standing on the ground. This was followed by light ones until about six o'clock, when a fairly heavy one was noticed, followed by light ones at frequent intervals. Conditions were such that it was thought advisable to place crockery on the floor. About nine o'clock things quieted down to such an extent that it seemed safe to retire for the night.

At about 10:50 there was a violent prolonged shock that jerked the small bunk-house in an alarming manner and made an infernal noise. Shelves were cleared of books, bottles, papers, etc., and water in cans on the floor was scattered about. A number of men present had been through the San Francisco shake of 1906, and it was, and is now, the general opinion that the Kennedy shake was more violent than that one.

The feature that produced much nervousness was the fact that the shocks did not cease, but one followed another, at frequent intervals, all night, connected by periods of uneasy feeling, slight tremblings and waves. The sage-brush was good camping-ground for the thirty or forty people of the town during that night and many slept outside for some time.

Next day the shocks were felt at close intervals. Some were timed at noon and occurred at less than minute intervals. An estimate based on frequency showed that during the three months following there were at least 500 shocks, mostly light ones, but many moderately heavy.

The visible signs left in Kennedy were slight, consisting of small cracks in soft ground, ore-piles flattened out, and rocks displaced on the slopes, but a rocky summit on the ridge above town was whipped to pieces, thousands of tons of rock rolling down into a gulch on the western watershed.

The most pronounced evidence of the disturbance is to be found on the east side of Pleasant valley, just where the detritus meets the steep mountain slopes. The valley is about three miles wide, covered with sage-brush, with steep slopes on the east and gentle ones on the west. The slip or settlement varies from 5 to 12 feet, measured vertically, and as much as 8 ft. measured horizontally. At places the bedrock is visible, showing signs of the movement. The line follows the contour of the hills closely, and at a few points there are two slips, one above the other. Its length is about 25 miles, and it extends along that part of the valley where the slopes are the steepest, disappearing gradually at both ends where the hills flatten. The indications are that this slip was a result of the earthquake and not the cause,

although it may have contributed to the length of the shock.

A ranch-house within 300 yards of the heaviest slip had much less shock than Kennedy, although only five miles from the nearest point, and the inhabitants did not know about the slip until next morning. The floor of the valley was, in places, cracked and displaced; water, carrying fine sediment, flowed out.

The photographs, taken on October 10, will give a general idea of the appearance of the slip. Streams flowing from the mountains into the valley were much augmented, but in Grass valley, near Winnemucca, the flow did not change much, and at one point a spring was cut off.

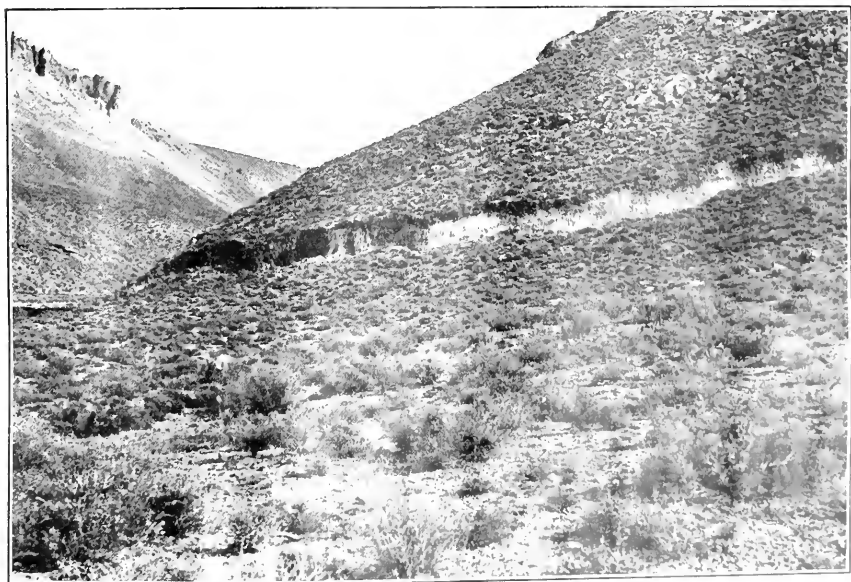
The number of shocks and the quietness of the surroundings favored a detection of the sounds that usually accompany an earthquake. It is stated that the velocity of an earthquake shock is about 200 miles per minute, which is about fifteen times the velocity of sound in air. The query is, why is the rumbling sound heard, in many cases, before the shake is felt? The sounds here have varied from sharp explosive to low rumblings, like distant thunder, generally heard a fraction of a second before the shock was felt. There have been many instances of sound without an appreciable shake, a few of shake without noticeable sound, and some of shake preceding sound. The fact that, as a rule, the sound precedes the shake and the further fact that there have been numerous cases of sound without appreciable shock lead to the suggestion that an earthquake may produce sufficient sound to be heard yet be so light as not to be felt. Under conditions prevailing here sound carries far.

[In the Bulletin of the Seismological Society of America for December 1915 we find an account of the Pleasant Valley earthquake by J. Claude Jones. He states that the fault appeared at the surface "as a fresh vertical scarp from 5 to 15 feet in height, running for over 22 miles along the junction of the alluvial apron and the base of the Sonoma range." The earthquake was as severe as that of 1906 in California, but the damage was small because the centre of disturbance passed through a sparsely populated region. If it had traversed a densely populated country, this earthquake would have ranked among the most terrible in history. An observer at Kennedy describes how he was suddenly awakened from sleep by "a great roar and rumbling" and how he was "thrown violently out of bed and buffeted in all directions." One effect of the earthquake was to increase the flow of streams and springs three or fourfold throughout northern Nevada. Immediately afterward the office of the State Engineer received over 50 applications for new water-rights. —EDITOR.]

Gold received at the San Francisco mint during May amounted to 197,535 oz. fine, 11,719 oz. of which came from Australia. There was 104,111 oz. sold. Silver receipts were 97,473 oz. Coinage was only \$9500 in one-cent pieces, and \$21,000 in one-centavos for the Philippines. The vaults contain \$371,681,472.13.



THE EARTHQUAKE-RIFT (WHITE LINE ALONG MOUNTAIN SIDE).



NEARER VIEW OF THE RIFT, SHOWING FAULT.

Copper Metallurgy at Garfield, Utah

By L. O. Howard

THESE notes are based on a visit to the Arthur mill of the Utah Copper Company and to the plant of the Garfield Smelting Company, at Garfield, upon the occasion of a recent excursion by the Utah section of the American Institute of Mining Engineers.

ARTHUR MILL. This has 13 sections enclosed in a structure 587 ft. long by 325 ft. wide. In it are treated daily 10,000 to 12,000 tons of low-grade copper ore from Bingham, the remainder of the 25,000 tons mined by the company being treated in the Magna mill, after which the Arthur is modeled. The Arthur mill was originally the property of the Boston Consolidated and, before it was taken over by the Utah Copper company, had attracted much attention as an exponent of the Nissen stamp. There were over 300 of these, which were used after the coarse breakers to prepare the feed for the Wilfley tables. A comparatively simple flow-sheet characterized the plant at that time. The finely crushed ore was delivered to 3-compartment hydraulic classifiers. The first two spigots were tabled, making finished concentrate and tailing. Middling was passed over Johnston vanners, likewise making a finished concentrate and tailing. After thickening, the slime was treated on other vanners for final products.

Construction of the old mill was along the most modern lines. Driving-shafts were placed close to the machines, and belting minimized. Pipes and launders were carried in tunnels beneath the floor. There were no elevators or centrifugal pumps. All machines had individual clutch-drives. The floor was of wood, special precautions being taken against spillage. The launders had high sides and steep pitches. Vanner belts had high flanges. The absence of elevators aided in keeping the floor dry. Launders were fitted with plate-glass bottoms.

The capacity of the plant was given in 1909 as about 2100 tons per day of ore containing 1.58% copper. The recovery was 21.8 pounds of copper per ton of ore, 80% of the total concentrate, containing 85% of the total copper, being made on the Wilfleys. After the merger with Utah Copper in 1910, a test lasting 30 days was made under identical conditions in the Magna and Arthur mills, resulting in the decision to remodel the Arthur mill to follow the process used in the Magna plant, in which a greater tonnage was treated for a higher recovery and at a lower cost. Without increasing floor space, the capacity was raised from 3000 to 8000 tons and finally to about 12,000 tons per day. The best of the constructive features were retained.

The increased capacity was obtained by the use of Garfield tables over which an enormous quantity of material was passed, with no attempt to make any fin-

ished products in the first stage. The concentrate was cleaned on Wilfleys, the tailing classified in the improved Richards-Janney mechanical-hydraulic classifiers, the finer sizes going to vanners while the coarse was re-ground in Chilean mills, re-classified and re-roughed on Garfield tables, from which the tailing was returned to the primary classifiers. The concentrate from the second set of tables was classified and cleaned on Wilfley tables and Johnson and Frue vanners.

The ore is received in 50-ton cars on the high line and dumped to the receiving-bins. These are 300 ft. long, 34 ft. wide, and 20 ft. deep, with a steel frame and wooden lining. They are equipped with scalping grizzlies, and the fine ore is by-passed around the coarse breakers. The bins have 80 discharge openings in two rows, delivering to chain-belt feeders driven by ratchet and pawl. Thirty-inch flat belts take the ore to the coarse-crushing plant at the end of the bins, where it is reduced to $\frac{3}{4}$ -inch in No. 8 Gates crushers and 72 by 20-in. rolls, this section being equipped with the necessary grizzlies and trommels to increase the percentage of coarse feed to the crushers. From the coarse rolls the ore is taken by two 18-in. belts up a 20° incline to the fine-ore bin, into which it is distributed by two self-tripping 18-in. conveyors. This bin is 580 by 22 by 20 ft. and has a capacity of 13,000 tons. The bottom is flat.

The ore is fed automatically to impact-screens, which appear to be about 8 or 10 mesh. The oversize is crushed in 37 $\frac{1}{2}$ by 15-in. rolls and elevated to the screens. The undersize is treated on Garfield roughing-tables, the concentrates being classified and cleaned on Wilfley tables and Isbell vanners. Each section has 6 Garfield and 2 Wilfley tables, and 4 Isbell vanners for the primary concentration.

The tailing from all these tables is elevated to the primary classifiers. These have four spigots and an overflow. The pulp from the first two spigots is re-ground to about 40-mesh in two 6-ft. Garfield mills, and is again classified for a second roughing on three Garfield tables, after which the tailing returns to the primary classifier. The product of the 3rd and 4th spigots of the primary classifier is re-classified in two 5-spigot secondary classifiers. The coarse product is treated on two Garfield tables, where the first clean tailing is made. The fine products go to 24 Isbell vanners, making finished concentrate and tailing. The concentrate from the Garfield tables is elevated to a classifier the coarse from which is finished on a Wilfley, and the fine dewatered in 24 Callow cones before final treatment on 36 Johnston and Frue vanners.

The flow is as nearly gravitational as it is possible to make it. The successive tables are strung out down the

section, each table-treatment being on a separate floor.

The above is substantially the treatment now given in 12 sections. In the 13th much experimental work has been undertaken. The fine crushing has been simplified. The impact-screens, rolls, and roll-return elevators have been eliminated, and crushing is done in two Marcy ball-mills, part of the product going to the Garfield tables and through the section, as in the other twelve. The slime-vanners have been taken out, and all of the material formerly treated there, as well as the finest material from the Marcy mills, is subjected to flotation. Much testing with oils and with modifications of standard practices, has been conducted, concerning which no data are available for publication, since the process is still in the experimental stage. The Janney flotation machines are used, the latest development including the Callow modification. In section No. 13 there are 12 mixing-cells and 30 roughing-machines, arranged in 6 units of 5 each, although the arrangement is flexible and may be changed if conditions indicate a different grouping as desirable. The machines in each unit are in cascade. Each machine, whether mixer or roughing, is driven by an individual 10-hp. motor, set on a vertical shaft in the middle of the machine. On each side of the agitation-compartment is a flotation-box, which is equipped with Callow mats for the introduction of air, thus combining mechanical and air agitation. The receiving compartment is equipped with a pulp-overflow to maintain an even feed, and the concentrate discharges automatically. A thick light froth was produced under the conditions obtaining at the time of inspection.

The feed to the flotation department is first dewatered in a 75 by 12-ft. Dorr thickener, elevated on a timber structure, from which the pulp is pumped to six units of two mixer-cells in series. Construction is under way to provide six of these large thickeners. After violent beating in the mixer-cells, the pulp flows to the first of the roughing-cells, oil being introduced at such points as is advantageous. Tailing from the first cell goes to the next lower machine, and so down through the series. All of the concentrate is received in a common launder delivering to the cleaning-department on a lower level. The machines used for cleaning are of the straight Janney type. No air-mats are used. Instead, the froth is skimmed by a board driven by eccentrics, the froth being much heavier and more compact than on the roughers. Whereas the roughing-machines were arranged with all the cells in a single line, end to end, the cleaning-machines, each of three compartments, are set side by side. They deliver concentrate from both sides, and may be operated in series or in parallel. Most of the cells at present make a finished concentrate, only the last few returning middling to the head of the series. Middling may be taken off any machine by swinging into place a hinged board that diverts the overflow to a launder.

Another set of these machines is provided for cleaning low-grade vanner-concentrate. Concentrate containing 8% copper and about 80% insoluble is brought up to 22 to 25% copper, thus allowing the vanners to

make a larger amount of low-grade concentrate and clean tailing, with a higher recovery than is possible with the vanners in the other sections.

The part played by flotation in the Arthur mill therefore is as a substitute for vanners in handling current slime, and as a cleaner for low-grade concentrate, from the Isbell vanners in particular, which in reality now treat a fine sand only, the slime having been separated and diverted as mentioned. This particular application may be regarded as the reverse of the customary treatment of tailing, in plants where the tables are run to make as high a concentrate as possible, depending on flotation to recover any metal lost in tailing. The advantage of removing the large bulk of tailing from the process is made possible by the low grade of the ore, and throughout the plant it will be noted that this practice is followed, becoming the principal factor in augmenting the capacity of the plant. All concentrate is laundered to drain-bins below the mill, and is reclaimed by clam-shell buckets loading into railroad-cars.

Excellent metallurgical results are being obtained in the experimental section, and, incidentally, on an ore the principal mineral of which is chalcocite, not so long ago regarded as unsuited to flotation. It needs no imagination to see the scrapping of approximately 1000 vanners and about 700 cone-tanks, in the two mills, as well as the elimination of the impact-screens and several sets of rolls and elevators.

An idea of the magnitude of the operations can be gained from the following list of machines in use before the adoption of flotation: 182 Garfield roughing-tables, 26 Wilfley tables, 832 vanners, 92 Richards-Janney classifiers, and 364 dewatering cones.

GARFIELD SMELTER. This treats oxidized and sulphide ores from Bingham and other districts in Utah, Idaho, Montana, Colorado, Nevada, California, Oregon, Wyoming, and Arizona, silicious ore from Tintic, and concentrate from the Utah Copper mills. The daily charge to the furnaces consists of about equal amounts of crude ore and concentrate.

The crude ore, with foreign matte, is unloaded from gondola-cars to bins or to belts that deliver to the top of one of two sampling-mills for oxidized ore, or to one of a similar pair for sulphides. These mills have a combined capacity of 2400 tons per day. They are enclosed in two buildings 83 by 70 by 72 feet.

The oxidized ore and the coarse sulphide ore from the sampler are taken by belt to the blast-furnace bins, of which there are four of a capacity of 2500 tons each. Concentrate is shovel-sampled to a system of conveyor belts delivering to 25,000-ton bins, where the fine sulphide ore from the sampler is also received. Coke, blaststone, slag, matte, and miscellaneous material are delivered by railroad-cars to long bins, arranged in four rows, 190 by 25 by 20 ft., divided into 28 600-ton compartments. These form part of the same structure with the blast furnace ore bins. Eight trolley tracks below serve the blast-furnaces from here.

The system of handling ores and fluxes is flexible

Material may be unloaded into bins, or upon belts delivering to the sampling-plants, or to blast-furnace bins, or may go directly by belt to the fine-ore bins.

There are four 20-ft. by 42-in. blast-furnaces equipped with oval settlers 25 by 15 ft. Each furnace has 22 4-in. tuyeres on a side. Jackets are 10 by 6 ft., six on each side, and one at each end. Twenty thousand cubic feet of air per minute is used per furnace at a pressure of 40 oz. The ore, flux, and coke (7%, made from Sunnyside coal) are loaded into 5-ton cars from the blast-furnace bins. Trains of five cars run to the top of the building, and deliver the charge through side-doors of the furnaces. The doors are operated by compressed air. The ore-column is 15½ ft. high. Formerly, with a column of 12 to 14 ft., the furnace was fed through a set of chutes delivering below the level of the feed-floor. The openings in the furnace on this floor were confined to end-doors through which barring-off was done. Only two furnaces are now in operation. With the increased delivery of flotation-concentrate, and the higher efficiency and lower cost of the coal-dust fired reverberatories, it is only a question of time when the coarse ore will be crushed and smelted in reverberatories.

Slag flows continuously into 10-ton slag-cars, operating in a tunnel below the floor-level. Matte is tapped to 10-ton ladles as required by the converters.

Alongside the blast-furnaces are six reverberatories, four of which are 112 by 19 ft., one is 112 by 20½ ft., and another is 120 by 20½ ft., with an average capacity of 460 tons each of ore and concentrate per day.

Concentrate is prepared for the reverberatories in 34 roasting-furnaces having a capacity of about 2400 tons per day. Sixteen are 6-hearth McDougalls, 18 ft. diam. Fourteen are 6-hearth McDougalls, 19½ ft. diam., and four are 7-hearth Herreshoffs, 19½ ft. diam. All are 18½ ft. high, and have air-cooled shafts and arms.

Larry cars operating on tracks over the reverberatories bring the calcine from the roasting-plant to the charge-hoppers of the reverberatories. Part of the furnaces are charged from hoppers on the centre-line of the furnace, and part through slots along the walls. The best results have been obtained by a combination of the two methods and it is intended to equip all furnaces with central hoppers and side-slots.

Although the plant was equipped with an elaborate oil-firing plant, the furnaces are now fired by coal-dust. Utah slack-coal is now used on the four furnaces in operation. It is received in gondola-cars and dumped to bins near the ground-level, from which it is taken to a 60-ft. Power & Mining Machinery cylindrical dryer, having a capacity of 225 tons per day. Moisture is reduced from 8 to 1%. An elevator and belt-conveyor deliver to bins over four Raymond pulverizers and vacuum-separators, which grind the coal so that 90% passes 100-mesh. The vacuum system lifts the coal to screw-conveyors, which deliver to the coal-hoppers above the furnaces. The coal is fed to Sturtevant burners by the usual methods.

The air in the furnace clears rapidly as the flue-end

is approached, and combustion is perfect. There is no trouble from ash-blankets on the charge, nor is the draught through the waste-heat boilers impeded. Three Stirling boilers are arranged in parallel in each reverberatory flue. About 400 horse-power is generated at each furnace.

The system has given excellent satisfaction. Furnace-capacity has been increased and the fuel-ratio decreased to 7:1. The minor advantages are many. The total consumption of coal is 300 tons per day for the four furnaces, which in 1915 averaged 459 tons of charge per day each. The oil-burning equipment is maintained at full efficiency as a reserve. In case of trouble with the coal-firing apparatus, it is only necessary to swing in the oil-burners and continue firing without interruption. So far no serious accidents have occurred. Care is taken to keep the pulverized coal in small units, and watch is kept for incipient fires, which have been easily and quickly extinguished.

Slag is tapped from the furnaces once per shift, 8 to 10 pots at a time. It is taken to the dump by steam-locomotives. About 1200 tons per day is made. Matte is tapped from near the fire-end into 10-ton ladles.

The coal-pulverizing plant, blast-furnaces, and reverberatories are strung out in a row along one side of the main building, which is 840 ft. long, 305½ ft. wide, and 92 ft. high. In the south-east corner are the blast-furnaces. At the west end of the south side are the reverberatories. On the north side opposite the blast-furnaces are six converter-stands. Three 60-ton Shaw cranes operating in a 60-ft. aisle serve the furnaces and converters.

The converters are of the Pierce & Smith, horizontal barrel, type, lined with magnesite brick. They are 10 by 24 ft. outside measurement, and 7 by 21 ft. inside. There are 37 1½-in. tuyeres on each converter. Tilting is by means of a hydraulic piston operating a cable wrapped around the converters. The charge to the converters consists of 120 tons of matte and 30 tons of silicious ore from Tintic. Three converters are in operation, producing about 60 tons of blister copper per day each. Slag is taken by cars to a casting-machine, making cakes 60 by 17 by 4 in., which discharge automatically after cooling into bins or chutes delivering to railroad-cars, which are hauled to the blast-furnace bins at a higher level.

Copper is handled by ladle and crane to an oil-fired cylinder, from which the pouring ladle is filled. There are two Walker casting machines, 24 ft. diam., carrying 26 molds. The cast-copper, 99.1% pure, is shipped to Perth Amboy or Baltimore for refining.

Independent flues are arranged for blast-furnace, roaster, reverberatory, and converter gases. The blast-furnace flue consists of three sections. One is of brick, 2300 ft. long and a cross-section of 320 sq. ft.; another is of steel, 620 ft. long, with a cross-section of 215 sq. ft.; and the third is of brick, 600 ft. long and 215 sq. ft. in cross-section. Gases from the blast-furnace pass through the flue to a dust-chamber, 300 ft. long and 920 sq. ft. in

section. The chamber has two 35-ft. sections and one 10-ft. section hung with vertical wires at intervals of 12 in., and provided with a mechanical shaking device. From the dust-chamber the gases pass to a new brick stack, 22 ft. diameter at the top, and 350 ft. high, or 430 ft. above the furnace-floor.

The flue from the roasting-furnaces, made of brick, is 1600 ft. long and 320 sq. ft. in section. Roaster-gases are conducted to the old stack, which is of brick, 30 ft. inside-top diameter, and 300 ft. high or 500 ft. above the floor of the reverberatory furnaces, this stack receiving gases from the latter also, after they have passed through the waste-heat boilers by means of a brick flue of which 1200 ft. has a section of 320 sq. ft., and 775 ft. a section of 360 sq. ft. Gases from the converters pass through 900 ft. of steel flue, 227 sq. ft. in section, to the Cottrell plant. After treatment in this plant they pass to the new stack. The Cottrell plant receives only gases from the converters; they can be handled at the rate of 250,000 cu. ft. per minute, in a chamber having a cross-section of 1775 sq. ft. and 105 ft. long, in which are 2500 5-in. pipes, 10 ft. long. The pipes are arranged in seven sections of 360 each. No. 10 iron wire is used for discharge-electrodes, which carry a voltage of 25,000. The power consumed is 60 to 80 kw. Several tons of fume daily are recovered that will assay over 50% lead. The fume is removed from the pipes by shutting off the gas from each section in turn, and striking the pipes with swinging hammers operated by a lever at the side. This equipment was the first of the multiple-pipe type, and has smaller tubes and a lower voltage than is the practice in later equipments. The high content in lead, the variation in the gas analysis, and the high temperature, alone or together, prevented the use of a bag-house, even with the aid of some neutralizing method, as it was impossible to feed the neutralizing agent automatically. In blowing leady matte it has been the custom to waste the lead. The application of the Cottrell process in the recovery of this lead is, therefore, of especial interest. An interesting description of the plant and the tests that led to its adoption may be found in the Transactions of the A. I. M. E., Vol. XLIX, page 540. It was written by W. H. Howard, consulting metallurgist to the company.

EXPORTS from the United States increased from \$2,484,000,000 in 1913 to \$3,555,000,000 in 1915, which is a gain of more than a billion dollars over a former total of about 2½ billion dollars. "Astonishing as it may seem," states the chief of the Bureau of Foreign and Domestic Commerce, "the increase in the export of munitions of war has been less than the gain in secondary war-supplies; while the largest increase has been in materials that have no direct relation to the activities of belligerent nations." Exports from the United States to South America increased 32%; those to Central America 34%; to Africa 51%; to Asia 135%; to Australia 17%; and to Canada 23%. One of the greatest gains that American industry is making in trade with foreign countries is that of good-will.

Determination of Antimony

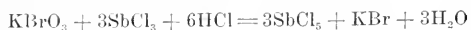
By Harel R. Layng

The following method is a modification of a process published in the appendix of Lowe's book. The modified method has been used by me in making over 1500 determinations of antimony contained in ores, alloys, and compounds, and it is the result of numerous experimental tests. The application of this method will enable a chemist to make as many as 50 determinations in a day. The method produces reliable results on samples containing arsenic or tin, and in this respect it differs greatly from the unmodified method, which is quite untrustworthy in the case of samples containing arsenic or tin. In order to produce reliable results it is necessary to follow the method closely.

SOLUBLE SUBSTANCES (alloys and sulphides). Place ½ gm. of the finely pulverized sample in a dry 300 cc. tall glass beaker; add 25 cc. hydrochloric acid and bromine solution (20 cc. of Br dissolved in 500 cc. HCl); cover with watch-glass and heat until the solution is complete, being careful always to have bromine present during the solution of the metal. Heat to boiling for a few minutes to drive off the excess of bromine. Cool to room temperature, add carefully 8 gm. (measured to within ½ gm. will answer for most purposes) of pure dry anhydrous sodium sulphite, then add 25 cc. hydrochloric acid in such a manner as to rinse the sides of the beaker. Cover with a watch-glass and place on stove, producing a heat sufficient to maintain the temperature of the assay at 108 to 109°C. When the assay has had exactly 50 minutes of such heat treatment add 40 cc. boiling hot dilute hydrochloric acid (1 part HCl to 2 parts H₂O) and continue heating for five minutes. Rinse the bottom of the watch-glass and the sides of the beaker with as little hot water as is necessary, add 4 drops of methyl orange solution (10 gm. to 100 cc. H₂O) and titrate the nearly boiling hot assay with a standard solution of potassium bromate, adding the bromate solution as rapidly as possible, avoiding such a rapid addition as will cause localization of reactions, stirring vigorously all the while; continue the rapid addition of the bromate until the pink color of the assay begins to fade, then proceed more slowly, finally finishing the titration drop by drop, stirring vigorously meanwhile. The end point is the disappearance of the last trace of pink coloration, or, in the absence of color-forming substances, such as salts of iron, the assay liquid is water-white. In the absence of iron or like salts, a yellow colored solution indicates that the titration is overdone.

Standardize the potassium bromate solution against pure pulverized metallic antimony, proceeding with the method exactly as before stated. The standards should check exactly. Run blanks on the chemicals, using the same amounts and proceeding exactly as in the case of the sample. The blanks sometimes require as much as ½ cc. potassium bromate solution. 1 cc. of KBrO

5 mg. Sb), depending upon the chemicals used. The bromate solution should be standardized often, and for particular work when the stove does not give a steady heat the standards should be run with each batch of assays placed on the stove. For ordinary work when an electric stove is used the solution does not require standardizing more often than once in three or four days. The titration is based on the following reaction:



The excess of potassium bromate, to finish the titration, oxidizes the methyl orange indicator, thereby destroying the pink coloration due to the action of methyl orange with hydrochloric acid. The standard potassium bromate solution contains 2.191 gm. KBrO_3 per 1000 cc. H_2O (1 cc. = 5 mg. Sb).

INSOLUBLE PRODUCTS (oxidized ores). Place $\frac{1}{2}$ gm. of the finely pulverized sample in a 20 cc. porcelain crucible containing about 6 gm. of an equal mixture of sulphur and sodium carbonate; mix well and cover the mixture with about 2 gm. of the sodium and sulphur flux. Cover with a porcelain cap and heat gently until the mass is fused; do not prolong the heating. Considerable experience is required to conduct this fusion method and I would advise that its use should be preceded by a number of experiments in order to obtain knowledge of the proper temperature at which to conduct the fusion. High heat or prolonged heat causes considerable loss of antimony, while, on the other hand, insufficient heat or time causes low results. Dissolve the fused mass with hot water; filter from solids; heat the filtrate to near boiling and add sufficient dilute hydrochloric acid ($\text{HCl} + 2\text{H}_2\text{O}$) to render the assay slightly acid. The mixture is stirred for a moment and allowed to stand warm with occasional stirring, to coagulate the precipitate of antimony sulphide, for about 10 minutes; add a little H_2S water and filter, using preferably an aluminum filter-cone. Wash with H_2S water. Rinse the precipitate from the filter into the 300 cc. tall beaker that originally held it with as little hot water containing traces of H_2S as possible; decant the excess of water from the precipitate in the beaker. Drive off the balance of the water from the beaker by means of moderate heating, finally finishing on a water-bath. Place the beaker containing the almost dry precipitate under the funnel containing the filter with its traces of antimony sulphide and pour 25 cc. warm hydrochloric acid and bromine solution through the filter little by little to dissolve traces of antimony; then continue to treat the assay according to the procedure customary with soluble ores as described previously.

REMARKS. It is unnecessary to filter from insoluble residue or free sulphur unless their presence is so marked that they obscure the titration. Small amounts of iron do not interfere. If iron is present to such an extent that it obscures the end-point or bleaches the methyl orange indicator it will be necessary to remove it by precipitating the antimony as a sulphide and filtering off the iron solution; in such a case proceed to get a

practically dry antimony sulphide precipitate and treat it just as if it were the sulphide from the fusion. With practice an operator will be able to conduct the titration without removing the iron, in cases of samples containing as much as 10% iron. The antimonious chloride and methyl orange are oxidized by the potassium bromate before the ferrous chloride is attacked. Zinc, lead, arsenic, or tin do not interfere. The arsenic and tin are volatilized during the 50-min. period of heating the solution containing sodium sulphite. Some antimony is volatilized during this period but its loss in this manner, which is constant, only amounts to 3 mg. when 500 mg. of antimony is present, which loss is corrected by the standardization. In cases where extreme accuracy is desired, it will only be necessary to have present the same amount of antimony in the standards as is present in the assay, in order to compensate for the loss taking place in volatilization.

The determination of arsenic in the presence of antimony appears to bother many chemists, judging from the returns given by different chemists on samples divided among them. I have made many experiments along this line and found that Lowe's modification of the Pierce method is absolutely reliable.

The following tests, a few of many that I have conducted, were run in duplicate and are given to show the value of the method:

A										Cc.	
No.	Mg. Sb	Mg. As	Mg. Sn	Mg. Fe	Mg. Zn	Mg. Cu	Gm. Na ₂ SO ₄	Min. Heat			Bromate
1	250	..	..	..	..	..	8	50			49.6
2	"	50	..	..	..	..	8	50			49.6
3	"	..	..	..	..	..	6	45			49.7
4	"	50	..	..	..	..	6	45			50.1
5	"	..	..	..	..	..	3	45			49.7
6	"	50	..	..	..	..	3	45			50.5
7	"	..	..	..	..	..	3	60			49.5
8	"	50	..	..	..	..	3	60			49.75
9	"	50	100	..	..	..	8	50			49.6
B										10 cc.	
10	200	..	..	..	..	..	25% Sol.	45			39.75
11	"	25	..	..	..	..	"	45			40.8
C											
12	"	..	..	..	..	..	8	50			40.1
13	"	..	..	25	..	..	8	50			40.1
14	"	..	..	..	..	25	8	50			41.6
15	"	..	..	..	50	..	8	50			40.1
16	"	..	..	..	..	..	8	90			39.6

Letters indicate that a different standard solution was used for each series of tests.

BARYTA, or barite, has been a bugbear to many operators in Summit county, Leadville, and in the San Juan. Now a new product called 'lithopone' is being produced at Leadville by the Western Zinc Oxide Co., this product being a mixture of zinc oxide and barite. It forms a pure white pigment that is used as paint in interior decorations, and to some extent in the manufacture of linoleum and rubber goods. The market for baryta has been good for the past year.

Mining in Utah

By L. O. Howard

Dullness in the metal market has not diminished activity in mining in this State. Interest in zinc is increasing. The success scored at Promontory, where a dividend-paying mine was opened at grass-roots, has spurred other prospectors with the hope of finding 'poor men's' mines. Zinc ore has been mined in the sandstones of south-eastern Utah, and a few cars shipped. About 38 miles west of Salt Lake, in Timpie canyon near Grantsville, there has been a rush of prospectors for zinc, and from one mine shipments are being made that will average about 32%. In Boxelder county, 28 miles north of Ogden, 50 tons of zinc ore is held for shipment at one mine, and others are being opened up. This mine is only $1\frac{1}{2}$ miles from an electric railway, and other facilities are said to be available. Zinc is also known to occur in the Santaquin district, south of Salt Lake City, and development is proceeding there.

Among the smaller operators much activity continues. The Utah Ore Sampling Co. has three plants at work. The one at Murray is sampling 500 tons of ore daily, and another plant of equal capacity is planned. At Silver City the plant is crowded with ore from the Tintic mines. A heavy tonnage is also being sampled at Park City. Inasmuch as a large proportion of this ore comes from the small mines, a healthy condition is evident.

The State Conservation Commission announces that it has arranged with the University of Utah for the establishment of a free information bureau, which will determine for prospectors the nature of any ore or mineral they may send. It is not intended to compete with regularly established assayers by making quantitative analyses, but the prospector will be aided in determining if he has found any unusual minerals.

Tungsten mining is at a standstill. Where low-grade ore was being mined and sent to custom-mills, operators face a decided loss, and several milling projects are held in abeyance. The ardor of the search for profitable antimony mines has cooled, although under reasonably favorable conditions the price is still ample to permit profitable exploitation. The potash industry is flourishing. The Mineral Products Co. at Marysvale continues to increase its production, while seeking to attain higher extraction. The principal vein is said to be opened for a length of 1000 ft., the last 800 ft. of which is 20 to 25 ft. wide, and is composed of nearly pure alunite. The Florence Mining & Milling Co. has selected a mill-site near the railroad and preliminary work has been started on a 100-ton plant that is expected to produce 10 to 15 tons of potash salts daily. For the present the ore will be hauled by teams from the mine, 13 miles distant.

During May the Lakeview mine shipped its usual tonnage of zinc ore from Promontory. Indications are that this district will become a producer of lead and copper ores also. The Lakeview has done enough de-

velopment on its lead ore-shoot to commence shipments. Another property has opened a vein of ore that will assay 15% copper, and while this average may not be maintained it is probable that a good tonnage of shipping ore will be developed.

The summer weather has stimulated activity in outlying portions of the Park City district that have long been idle; for instance, at the American Flag, where a new company has been formed to undertake thorough exploration; also at the Daly Judge Extension, where the old workings are being cleared with a view to operation; and at the Iowa Copper, at the head of Thayne's canyon, on Scott hill, near the crest of the Big Cottonwood divide, which has been made the subject of a reorganization to provide funds for development.

Geologists of the Survey have started a more thorough study of the Alta-Cottonwood-American Fork district. F. F. Hinte, of the geological department of Lehigh University, is associated with the Government men in the work. His selection is a happy one, for to him is due the only comprehensive report on the stratigraphy and structure of this region, and his collaboration may be expected to aid in clearing some of the points of difference appearing in various descriptions of the district. Concerted effort by local mining men is responsible for the prompt beginning of this work. It is to be hoped that the publication of results will follow as promptly, and that these men will not be placed on other work before they have completed their task. There appears to be a tendency recently to avoid the repetition of the Butte and Park City blunders, so that the information may be expected to be available before another spring.

D. C. Jackling of the Utah Copper has announced that in two or three weeks work is to begin on the first 2500-ton unit of the long-expected leaching-plant. Details of the process are withheld, but it is known that sulphuric acid will be provided by the plant that is being built to utilize the Garfield smelter-smoke. About 40,000,000 tons of oxidized ore containing 1% copper is available for treatment.

The overloading of the lead smelters has resulted in a demand from them that Tintic shipments be curtailed. The large producing mines will probably confine their shipments to the better class of ore. The Eagle & Blue Bell was first forced to reduce shipments from 150 to 100 tons daily, and later to 50 tons. The Mammoth and Chief Consolidated have also had to curtail. Many miners have been laid-off, but as many as possible are being employed on additional development work. The Centennial-Eureka, owned by the United States Smelting company, will continue to ship at a maximum rate.

Shipments from Big Cottonwood canyon are still curtailed owing to the slowness of contractors in improving the road. It happens that the part that is causing delay was a typical mining operation, so that an effort to do the work cheaply has delayed transportation and hampered the mining companies unnecessarily. It is evident now that it would have been better for the mining companies to do this portion of the work themselves.

Blasting Practice at Chuquicamata, Chile

By Howard W. Moore

The disseminated ore at this mine is found in coarse grano-diorite. The mineralization is chiefly along the planes of fracture, but it has impregnated the entire country-rock. The important minerals are: chalcantithite ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$); brochantite ($\text{CuSO}_4 \cdot 3\text{Cu}(\text{OH})_2$); krolnikite $\text{CuSO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$; pisantite $(\text{FeCu}) \text{SO}_4 \cdot 7\text{H}_2\text{O}$; and atacamite $\text{Cu}_2\text{CH}_3\text{O}_2$. The average copper content of the ore is 1.65%. Steam-shovel benches 40 to 100 ft. high have been laid out parallel with the long axis of the orebody on a 3% grade.

The first method of breaking the ore involved the use of vertical churn-drill holes, set in rows that were 40 to 50 ft. apart, with the holes in each row about 25 ft. apart. These holes were drilled to a depth a few feet below the grade of the shovel-bench and 'sprung' five to seven times with 60%, or sometimes 75%, dynamite. A chamber 6 to 8 ft. diameter was formed by this springing, and the chambers were then loaded for the final shot. The cost of this drilling proved so excessive that it was abandoned, and blasting is now done by means of 'tunnels,' a method found more successful and economical than the original practice. The churn-drilling cost about \$9.80 per foot, while the tunnel-work, including

sinking, cross-cutting, and driving, is costing only \$5 per foot, and all of this work is accomplished by hand-drilling.

The tunneling is done with considerable precision. Shafts are sunk in several well-chosen parts of the orebody, to a depth of 3 metres below the grade of the shovel-bench. From the bottom of these shafts, cross-cuts are run parallel with the short axis of the orebody, and drifts are extended from the cross-cuts parallel with the long axis of the orebody, and about 15 metres apart. These drifts receive the charges of explosive; the method of loading is represented in Fig. 1. Beginning at a face of the drift, 10-metre centres are measured for the powder chambers, and the charges are calculated for each chamber by means of cross-sections through these centres, as shown in Fig. 2. By plotting the cross-section to scale, and drawing the line of least resistance, it has been found by practice that approximately 463 lb. of black powder should be used for every metre as measured on this line of least resistance. For dynamite of 60% strength, this figure should be divided by 2.64.

The powder is loaded in sacks of 100 lb. each. It may be loaded in cans, but is naturally more compact if

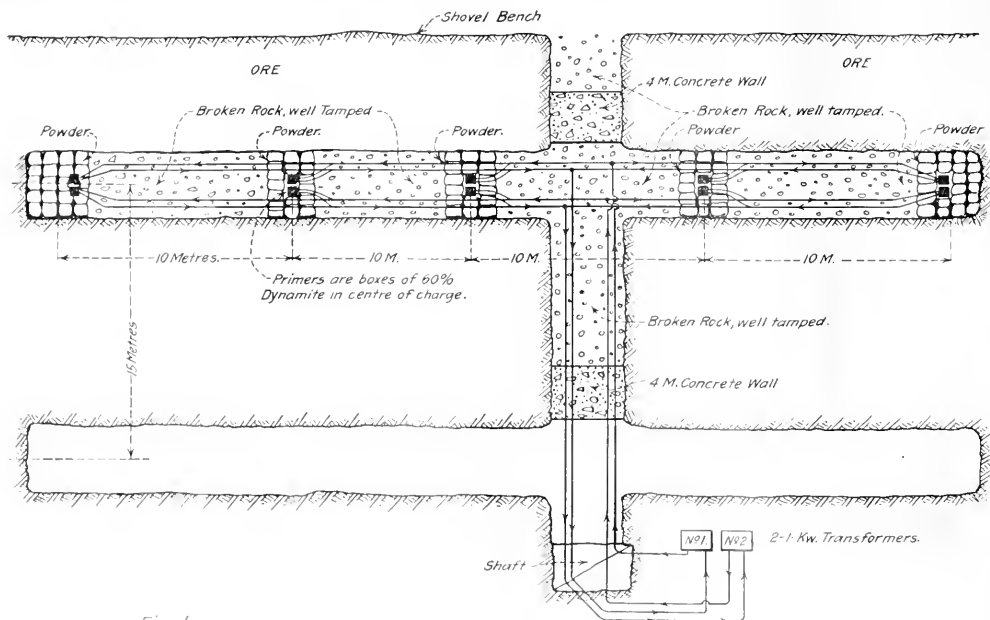


Fig. 1.

Plan of Tunnel Blasting, Chuquicamata, Chile.

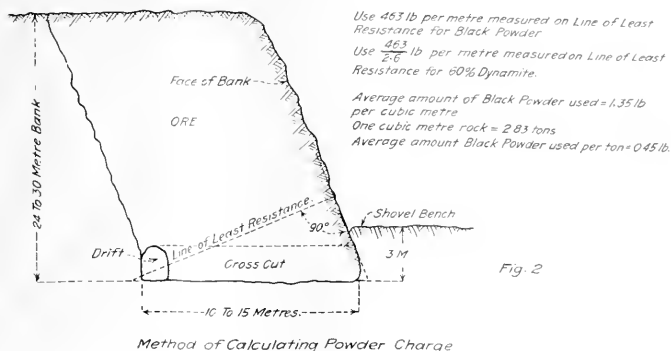
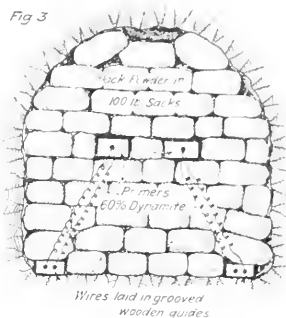


Fig. 2



Method of Loading Tunnel for Blasting

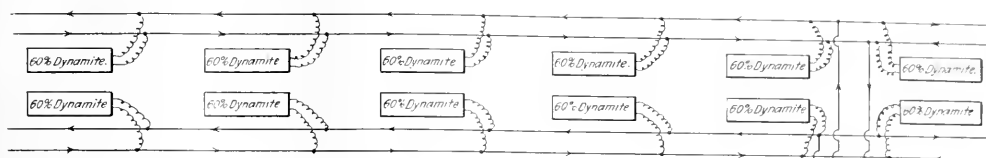


Fig. 4.

Transformers, 1 kw - Alternating Current, Single Phase -110 Volt
Caps; in Series Two Series
Wire, No 12 or 14 B & S Gauge Rubber Insulated
Amperage required for 20 Caps, = 0.75 Amp
Volts required for 20 Caps, = 110 Volts.
Ohms resistance of 1Cap and 9 metres of fuse wire = 200 Ohms

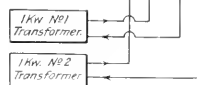


Diagram for Tunnel Blasts

loaded in sacks. The interstices between the sacks are filled with sand or any kind of convenient packing. In the centre of the charge, two boxes of 60% dynamite are placed, which serve as the 'primers.' One electric cap is carefully connected with each box of dynamite, and the lead-wires are carried from the primers, along the floor of the drift, in grooved stringers (2 by 3 in. material with $\frac{3}{4}$ -in. groove) provided with $\frac{1}{2}$ -in. covers carefully nailed-down after the wires are in place. A cross-section through the centre of the charge is shown in Fig. 3. The lead-wires and stringers are cut long enough to reach from one charge to the next, and after the chamber has received its charge of powder, broken rock is filled-in closely from wall to wall and from floor to roof. Charging of the other chambers is done in a similar manner.

It will be noticed that two separate series are carried. This is done to prevent a misfire, which might result from a broken circuit in one or the other series. Each series is on a different transformer. From careful experiments it was found that for a series of 20 caps, a current carrying 0.75 amperes under 110 volts should be used for a successful 'fire.' Each cap showed a resistance of about 2 ohms, that is, the cap plus about 30 ft. of fuse-wire. The present practice of wiring a charge is shown in Fig. 4.

After the drift is loaded, the cross-cut leading from this drift back to the other workings, is filled with broken rock to within 4 metres of the first drift back. At this point a solid concrete bulk-head is put in, not so

much because of the resistance it affords, as to seal hermetically the workings back of the shot, for preventing the filtration of gases after the explosion. The handling of such large quantities of explosive is somewhat hazardous, but the work is so systematically and carefully superintended that, to date, no accidents have occurred through carelessness.

[The first method tried and discarded, that of vertical churn-drill holes, is used successfully at the Nevada Consolidated copper mines, where the ore is softer than at Chuquibambata. EDITOR.]

IRON-ORE mined in the United States in 1915 amounted to 55,526,490 tons, worth \$101,288,984 for the 55,493,100 tons shipped. This is the greatest output in any year save 1910 and 1913, and 14,000,000 tons more than in 1914. The average value was \$1.83 per ton, according to the U. S. Geological Survey. There were 27 producing States, some of them for flux only. Minnesota led with 33,464,660 tons, Michigan produced 12,514,516 tons, Alabama 5,309,354 tons, Wisconsin with 1,095,388 tons, and New York with 998,845 tons. Taking the districts, Lake Superior produced 85%, and Birmingham 8.5%. Seven mines including the Mahoning, Hule-Rust, and Red Mountain yielded over 1,000,000 tons each, 2,311,940, 2,307,195, and 2,138,015 tons respectively. The ratio of pig-iron to iron ore was 53 15%. The output of iron was 29,916,213 tons, worth \$13.21 per ton at furnaces.

CONCENTRATES

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

BRASS as now made for cartridges contains from 67% copper and 33% zinc to 71% copper and 29% zinc.

WATER-POWER of the world is estimated at 700,000,000 horse-power; 21% in Africa, 21% in North America, 14% in South America, 32% in Asia, 2% in Australia, and 10% in Europe.

COST of development in the Hollinger mine, Ontario, is as follows: diamond-drilling, \$1.60 per ft.; cross-cutting, \$6.40; shaft-sinking, \$42.32; driving, \$10.10; raising, \$16.17, and winzing, \$39.20. These costs are low for the district, notably those for diamond-drilling and cross-cutting.

NAILS driven in wood that is exposed to alternate wetting and drying are likely to work out. The wetting swells the wood and moves the nail, which does not return to its original position when the timber dries. It is for this reason that timber structures bolted together and exposed to weather require screwing up at intervals.

SILVER ORE at the Rosario mine, Honduras, averaged 16.97 oz. per ton in 1915. In recovering 87.45% of this there was used 3.93 lb. of sodium cyanide, 0.211 lb. of lead acetate, 35.5 lb. of lime, 3.58 lb. of tube-mill pebbles, and 0.98 lb. of zinc-dust per ton of ore treated (323 tons daily).

FIVE HUNDRED AND TWO FEET of advance in one month was made last January in the Tiger adit (8 by 9 ft.) of the Burma Mines Corporation by Chinese miners, under white shift-bosses, using three Layner-Jugersoll drills at the face and mule traction up to a length of 6000 ft. The rock is rhyolite.

MANGANESE STEEL, as the term is used commercially, is a hard, tough, ductile steel. But sudden cooling from a heated condition is apt to make this steel too ductile, while slow cooling makes it brittle. It is used for such purposes as parts for rock-crushers and dredges, but is not suitable for the largest castings. The proportion of manganese is about 12%, with carbon 1½%.

ELECTRIC HOISTS of two types are used by the Cleveland-Cliffs Iron Co. They are the direct-current hoist operated by the Igner system, and the induction-motor-driven hoist. Induction motors, directly geared to the hoist, are used where the ore can be hoisted in loads as small as three tons, at a speed as low as 1000 ft. per minute. Where a greater product is required, the Igner system is employed. With a larger generating-station, however, greater induction motors could be used. It is

stated that in designing hoists for electric drive it is desirable to make the rope speed as low as possible, rather increasing the weight of the live load as necessary, than going to high speeds with light loads.

LEACHING TAILING at the Calumet & Hecla will be in operation during July. The process involves the use of ammonia supplied by the Semet-Solvay company of Syracuse, which makes the liquor from by-product coke manufacture. Two thousand tons of tailing is to be treated daily, the cycle of operations to occupy 96 hours. Eight vats 54 ft. diam. by 12 ft. high, holding 1000 tons each, are part of the plant.

STRONGER DETONATORS than formerly are being used, because the slight extra cost is many times repaid by the better explosion obtained in the charge. Suppose, for instance, that three sticks of powder in a hole are fired by a weak detonator, No. 3. The detonator will undoubtedly cause sufficient impulse to explode the first stick. The explosion of this will be communicated to the second, and thence to the third, and the whole charge will apparently explode. Yet among the resultant gases, there can probably be detected fumes such as are caused when an explosive burns rather than entirely detonates. The miner speaks of the powder as having 'burnt.' If instead of a No. 3 detonator, a No. 8 were used, the initial impulse would be transmitted right to the extreme end of the charge, instead of being passed from cartridge to cartridge. When the explosion has to be passed from cartridge to cartridge, it is possible that toward the end of the charge the impulse is so diminished in force as not to create that instantaneous transformation which is necessary for the best result. Detonation in such a case approaches the nature of combustion, and unexploded sticks of dynamite may be left in the holes.

EUCALYPTUS is a genus of tree indigenous to Australia, and called there 'gum-trees,' by reason of their resinous leaves and fibrous bark. One species, *eucalyptus globulus*, or blue gum, was brought to California over 50 years ago, and it has also been introduced into southern Europe, northern Africa, India, and the islands of the Pacific. The eucalypti are rapid in growth, straight, with few branches, and generally reach a great height, as much as 500 ft. on the Dandenong range, in Victoria. An oil of camphoraceous odor is obtained by aqueous distillation of the leaves, and this has been used in the making of perfumes and varnish, as well as for the flotation process in metallurgical plants. In Australia, several species of the timber are employed extensively for mining purposes. The jarrah and karri are well liked for head-frames, mine-timbering, and for building mills. The wood is hard and heavy. Jarrah is nearly double the weight of Oregon pine, so that a disadvantage is found in paying freight for a long haul, and it is likely to be short-grained. The eucalyptus in California has not as yet been used much for timber in mines, as other woods of lighter weight and less resin are available.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

ANOTHER LARGE DRAINAGE SCHEME.—EMPIRE ZINC AND WESTERN COMPANIES' PROGRESS.—DEVELOPMENT IN PROSPECT MOUNTAIN.—DOWN TOWN OPERATIONS.

What is considered to be the greatest mining venture ever undertaken in the Leadville district is now under way at the new Mikado shaft on Iron hill, as was briefly mentioned in the PRESS of June 24. George O. Argall, manager of the Iron Silver Mining Co., has organized one of the strongest combinations that have entered the district, and has secured control of a large tract of valuable territory extending through Graham park to Stray Horse gulch, and along the foot of Iron hill. The tract includes eight full claims; the R. A. M., Pyrenees, Devlin, and Cyclops of the Marion group, and the Sawtooth, Keystone, Venus, and Young America comprising the Mikado group.

Development of the property is to be carried on through the Mikado shaft, which is 1206 ft. deep. At present it is in poor condition, both inside and on the surface, requiring the installation of a new surface plant and re-timbering throughout the entire depth. Water stands at the 800-ft. mark in the shaft, making it necessary to install good machinery as soon as the shaft has been repaired to the water-level. Mr. Argall announces that he is prepared to fully equip the property with first-class machinery, and make all the necessary preparations in the shaft, an undertaking that is estimated to cost over \$300,000.

Construction work at the Mikado has been under way for two weeks under the direction of the contractor, Kenneth McLean. The largest head-frame in the district is being erected over the shaft. It is of four posts, 60 ft. high, with a 31 ft. base. It is being constructed of the best Oregon fir. The first and main bent of the frame has been hoisted into position; the work of assembling the secondary bent and supports is progressing rapidly. The completed frame will weigh more than 20 tons.

Expensive hoisting machinery has been ordered for installation as soon as construction work is finished. It is stated that the engine alone will cost \$10,000. Following the completion of the surface work, shaft timbering will begin. Several carloads of Oregon fir square-sets and lagging have been delivered at the property for this work.

Drainage of the working and the surrounding basin from the 800-ft. level to the bottom of the Mikado shaft will be the most difficult point of the undertaking. Many great old stopes in the sulphide zone exist throughout this area, and draining will be comparatively slow. Excellent machinery has been ordered for the work. Sinking of the shaft an additional 100 ft. is also planned.

The ore-belt which is to be explored through the Mikado shaft is one of the most extensive in the district. Several years ago this was the productive centre of Leadville. At that time such properties as the Maid of Erin, Adams, Mahala, Robert Emmet, Wolfstone, R. A. M., and Greenback were operating below 1000-ft. depth, and were shipping a large quantity of lead-silver ore. The decrease in the value of silver and the low metal market which prevailed for several years following, caused these properties to suspend operations in the sulphides, and those that had no other ores were forced to close entirely. Many of these famous old mines have been

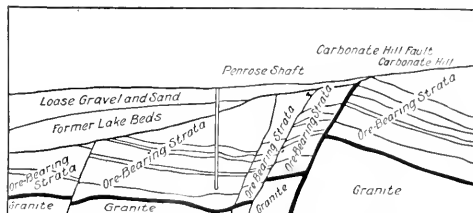
idle for years, and it is only the recent revival in the metal market that has opened another period of activity for them. The large orebodies formerly abandoned are now very valuable and should produce millions of dollars under a continuation of the present favorable conditions.

The Empire Zinc Co., which recently purchased the Robert Emmet and other properties from the Small-Hopes-Borcel Mining Co., has undertaken extensive work preparatory to developing the immense bodies of sulphide ore known to exist in its holdings. This territory adjoins the Mikado project on the north-west. The old McCormick shaft on the Result claim is being re-timbered and a new surface plant has been installed, while extensive work is being done through the Emmet shaft.

The Western Mining Co. is draining the Wolfstone shaft to the 1000-ft. level, planning to get into the sulphide ores again. The Greenback is also active again, and as soon as the water has been taken out of the property through the Mikado and Wolfstone, work will be done in the rich stope that has stood idle for a number of years.

All the preliminary work, with the exception of the Mikado, will be completed during the summer, and there is no doubt that the tonnage of the district will be doubly increased by the production from these properties. There are thousands of tons of valuable ore now opened and blocked-out in these properties, and the development that will be carried on at greater depth will uncover much additional ore.

The draining of the Down Town basin through the Penrose shaft is now complete to a depth of 875 ft., the lowest level



GEOLOGY OF THE DOWN TOWN AREA, LEADVILLE.

in the property. The unwatering of the Down Town section was started on May 8, 1915. At that time the water stood at a point just 230 ft. below the collar of the shaft. The water was drained from the property to the full depth of the shaft on June 14, 1916. Pumping has been done by two electric centrifugal sinking pumps of 1500 gal. capacity, and two relief pumps of the similar capacity.

Work is now under way preparing the bottom station for the installation of a 2000 gal. four-stage motor-driven centrifugal station pump recently delivered by the Providence Manufacturing Co., makers of all the pumps used at the property. The pump is a vertical machine, and requires greater height in the station than the old steam pumps that formerly were operated there. The new pump will be propelled by a 650-hp. motor, the largest that has even been in use at Leadville. The motor is a new type patented by the General Electric Co. in June of last year. The station machinery will be in place by the end of the coming month, and immediately following an extensive

mining campaign will be taken up in the upper workings of the property where immense bodies of carbonate of zinc and high-grade manganese and iron ores have been uncovered.

The most important discovery of ore made in the district since the early 80's has been made in the Valley adit in Prospect mountain, in charge of Warren F. Page. At a depth of 150 ft. below the adit level, as mentioned in the Press of July 1, an immense body of oxidized iron, containing good values in silver and manganese, has been opened. The ore is identical with that found in the first contact of Carbonate, Fryer, and Breece hills, and is regarded as conclusive evidence of the continuation of the regular Leadville formation into the vast and undeveloped area of Canterbury hill and Prospect mountain. The property is now being equipped with large ore-bins and necessary buildings for the handling of a large output. Electric power is available in the adit, and is used for hoisting at the interior shaft, a distance of 1700 ft. from the portal.

Prospect mountain, lying immediately north of Big Evans gulch and on the trend of the strong ore-shoots developed in Fryer, Breece, and Carbonate hills, comprises an area of unlimited possibilities that for years has been neglected. Mining men have long been convinced that the Leadville formations known south of the Big Evans to Iowa gulch did not exist north into Prospect mountain, and looked on this territory as absolutely barren. It has only been recently that attention was turned in that direction, due undoubtedly to the success of the Valley, Silver Spoon, and New Monarch properties in Big Evans gulch. Drill-holes driven from the lower workings of these mines into the mountain disclosed remarkable results. It is stated that one of these holes from the Valley cut 40 ft. of ore.

The driving of the Valley adit was immediately undertaken by Mr. Page following the drilling, and the finding of ore in the interior shaft is the result of several months' continuous work. It occurs in the blue lime and porphyry that form the first contact throughout the now developed sections of the Leadville district. Huge bodies of rich ore have been mined in this zone throughout Carbonate, Fryer, and Breece hills and there seems to be no doubt that deposits equally as extensive will now be uncovered in Prospect mountain. Deeper development will also open the continuation of these ore-shoots into the second contact.

The importance of the opening of this vast and new territory can hardly be estimated. Should the formations hold as great a store of wealth in Prospect mountain as they have in the other parts of the district, Leadville will enjoy a great 'comeback.'

OATMAN, ARIZONA

NOTES ON THE PRINCIPAL PROPERTIES.

The Oatman district continues to be the centre of attraction in the south-west. Etienne A. Ritter has made an extensive study of the area, and in commenting upon the conditions prevailing there considered that it will prove to be a great gold producer. James G. Ray has just completed a long geological survey of the Esperanza Mining Co.'s ground. This is the most complete investigation which has been made of any property in the district, and is an exhaustive study of the geology, petrology, and mineralogy of the southern section of the field. Mr. Ray's recommendations as to further mining of the property will be carried out as rapidly as possible.

Persistent rumor continues to the effect that a fine development has been made on the new 1100-ft. level of the Tom Reed. Officials of the company will not confirm or deny this report. Ellis Mallory has started preparing a complete geological map of the Tom Reed company's holdings. The annual report of the company for the year ending March 31, 1916, has just been issued. It shows that during the year 5718 ft. of work was done. There was 29,916 tons of ore milled, the average value being \$22.12. The extraction was 98.6%. The yield was \$661.

571, against an average of \$739,690 for the preceding seven years. Total production is \$5,833,702. Dividends paid during the past year amounted to \$163,720, or 18% on the par value of the outstanding shares. It was estimated that 11,000 tons of ore was blocked-out in stopes at the end of the year.

The Gold Ore continues to ship 30 tons per day to the Gold Road mill, the extraction being better than \$20 per ton. Development of new ore continues.

At the Big Jim 35 men are at work, and drifts are being driven in both directions on the vein on the 400 and the 485-ft. levels. The faces of the four drifts are said to be in ore averaging \$35, \$150, \$30, and \$100 per ton, respectively. The first two values are for the drifts at 400 ft, which have been carried in farther than those on the deeper level.

Developments in the Ivanhoe property are the centre of interest in Oatman. At a depth of 500 ft., and a distance of 395 ft. from the shaft, and after cutting through an intrusive dike of quartz-porphyry, the main vein, which was the objective, was cut. On June 27 it had been penetrated 27 ft. beyond the foot-wall, with no hanging wall in sight. The vein filling is quartz, with some calcite and adularia, considerably stained by limonite, and highly oxidized.

Steady work continues in the Arizona Tom Reed, both in shaft-sinking and in lateral work on the 400-ft. level from the Pioneer shaft. Development in the Pioneer property, adjoining, overshadows in interest the work in the Arizona Tom Reed property. The two companies are developing the same main vein systems, it is estimated that the strike of the ore-shoots being developed in the Pioneer carry them into the adjoining property, so development of the one is considered as development of both.

In the Boundary Cone, driving operations on the 750-ft. level have not yet reached the zone where the downward continuation of the ore-shoots opened at 550 ft. are to be expected. The formation is promising.

In the United Eastern, blocking-out ore continues. Concrete foundations for the 200-ton mill will soon be completed, after which actual erection of the mill will be rushed.

The Black Range is steadily driving in ore on the 300-ft. level. Gold content is spotted, above \$30 for a few feet, and then dropping to very low-grade material.

Although a number of companies that entered the Oatman district and commenced operations on a 'shoe-string' are in financial straits, and some of these operators are sending out pessimistic reports, optimism among those who entered the field prepared to withstand a long development siege is higher than ever. Mining activity, backed by ample funds, is greater than at any previous time.

It is reported that the head of the Burro Creek Electric Company, George A. Thayer, was at Oatman during the last week, seeking to get contracts from the larger companies and mills in this district. Mr. Thayer visited the managements of the Tom Reed, Big Jim, Gold Road, United Eastern, Oatman, Paramount, Arizona Tom Reed, Golconda, and Boundary Cone mines, and will visit some of the smaller properties as they get ready to use power. The company has received a permit from the Arizona Corporation Commission to sell power here. The Burro Creek company generates its power at Burro creek, about 65 miles away, and will build a line into Oatman, which is expected to be completed within the next 12 or 18 months.

The present rate for current here is from \$12.50 to \$14 per hp., but the rate quoted by Mr. Thayer will reduce this to about \$5 per hp.-month. This reduction of electric current will have a material effect in stimulating development in this centre.

There are 125 properties being worked in the Oatman district. In the Black Range mine, 5 miles south-east, 3 ft. of \$29 ore has been cut at 300 ft. depth. Another note on this property appears in the above column.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

The Alaskan mining industry will have a prosperous season in 1916, according to a statement by Alfred H. Brooks, of the U. S. Geological Survey, covering the operations during the first six months of the year. Copper mining will probably show the greatest advances. About 15 Alaska copper mines are now shipping ore, and developments are being pushed on others, indicating that they may become producers before the end of the year. The gold lode mines of Alaska will also make a larger production this year than last, but it is not now expected that the placer mining will show any marked increase. The shipment of antimony from Alaska continues, and some tungsten ores have already been shipped from the Fairbanks district.

JUNEAU

May yields of the mines on Douglas island were as follows:

	Alaska Mexican	Alaska Treadwell	Alaska United
Stamps dropping	120	540	300
Ore crushed, tons	16,667	82,082	44,338
Gold from all sources.....	\$17,228	\$135,396	\$82,691
Yield per ton	\$1.02	\$1.65	\$1.80
Operating expenses	\$24,347	\$96,420	\$70,643
Construction charges	\$3,542	\$17,255	\$11,020
Profit .....	.....	\$20,278	\$200
Loss	\$10,833	.....	.....
Other income	\$3,730	\$11,290	\$3,730

ARKANSAS

BOONE COUNTY

The need of a custom mill at Harrison is felt considerably, as both carbonate and sulphide zinc ore are mined, which is dumped for future treatment.

CALIFORNIA

AMADOR COUNTY

(Special Correspondence.)—Unwatering of the old Eureka mine is progressing satisfactorily. About 130 ft. of the north shaft has already been drained, and the timbers repaired for 60 ft. The old timbers were found to be solid, and many of the sets would not have to be changed had it not been for the settling of the ground around the collar of the shaft, which caused the sets to move slightly out of place. A cooling-tower has recently been erected near the compressor-house for cooling and re-utilizing the water used in pipes as a water-jacket for the working parts of the large air-compressor. This contrivance is something new for Mother Lode mines, as heretofore the mines in this part have wasted the water, except where it could be utilized as battery water.

Sutter Creek, June 30.

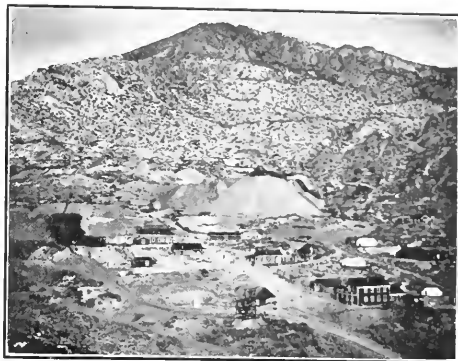
BUTTE COUNTY

A large diamond was found in the Cherokee district last week by J. Hufford.

INYO COUNTY

At a point 800 ft. from the portal of its Buena Vista adit, the Cerro Gordo Mines Co. has picked up the lower extension of its orebody. It is 25 by 30 ft., with 115 ft. of backs. Some of the zinc-lead ore is high grade. Zinc ore shipments to Al-

toona, Kansas, are 40 tons daily. Lead ore will be dispatched soon. Copper ore has been opened in the Blue Jay claim. All machinery is motor driven. Recent improvements cost \$50,000. Gold-silver-lead-copper slag from past smelting (1869) is being



CERRO GORDO MINE, INYO COUNTY.

shipped at the rate of 60 tons per day. About 25,000 tons of this material is available at low cost. An aerial tram delivers ore, etc., to Keeler, 5000 ft. below, and 8 miles by road. A mill to \$250,000 is contemplated. J. C. Climo is superintendent, and Louis D. Gordon is general manager, in charge of 75 men.

NEVADA COUNTY

For the purpose of hauling ore to the Golden Gate mill from the Narrow Gauge railroad, a 900-ft. tramway is soon to be constructed. It is said that the Pacific Western Commercial Co. is to treat tungsten and other ore from its mines in other districts at this 30-ton mill.

As 30 miners employed at the Spenceville copper mine were not paid for several months they have gone on strike.

PLUMAS COUNTY

The Engels Copper Co., near Taylorsville, is paying an initial dividend of 12c. per share, equal to \$22,000, on July 20. Monthly distributions are to follow. Net earnings for the past 6 months were \$275,000. Of this, \$137,000 was set aside for development.

SAN BERNARDINO COUNTY

(Special Correspondence.)—On the California side of the Colorado river, around Vidal, there is growing activity. The Bendigo Mines Co. of Los Angeles, which has shipped 450 tons of gold-copper-silver ore netting \$45 per ton during the last few months, is preparing another lot. Several individual operators nearby are also preparing shipments of ore, which as a rule go to the Hayden smelter in Arizona. One notable find of high-grade silver-lead ore has been made in the district during the past week, while on another property an 8-ft. vein of copper-silver-gold ore has been opened, yielding ship- ping ore at several places on the surface.

On the Parker side of the Colorado river in Arizona mining activity is increasing, and so much ore is being shipped that

several interests are considering building a custom smelter on the Colorado river near Parker, where it may be reached by mine operators on both sides of the river.

Vidal, June 28.

SHASTA COUNTY

Regarding the electrolytic plant to be erected by the Mammoth Copper Co. at Kennett, the general manager, G. W. Metcalfe, states that the plant will cost \$350,000. There is 25,000 tons of bag-house dust to treat, and more is being caught each day the blast-furnaces run. One thousand horse-power will be required. The chief element of cost is electric power. The company will build the plant on Backbone creek, a mile above the smelter. The process was developed at Winthrop by the Bully Hill Copper Co., which has spent 8 years experimenting. The Mammoth Copper Co.'s chemists spent four months last winter and spring at Bully Hill elaborating the process, which is something almost entirely new. Twenty-three per cent of the bag-house dust is zinc. It contains also gold, silver, and copper, as well as cadmium, bismuth, and antimony. The plant when at work will give employment to 50 or 60 men.

On Boulder creek, four miles west of Gibson, chrome and molybdenite deposits are being mined, 30 and 10 men, respectively, being employed. A car of chrome ore is to be shipped twice a week.

At French Gulch, 30 stamps are crushing 100 tons daily at the Gladstone mine. Ore is extracted from below 1000 ft. depth.

COLORADO

BOULDER COUNTY

Work is being rushed on the new 100-ton Degge-Clark tungsten mill in Boulder canyon. It is hoped to have the plant ready by July 15. Crushers and rolls are part of the equipment. Mr. Degge has been purchasing ore right along. He says: "I have absolute confidence in tungsten, and am convinced that there will soon be a steady market at \$30 to \$50. I expect to be a constant buyer at the market price, and as independent producers it is to our interest to keep the price up, and we shall do all in our power to do so."

When leases on the Primos company's properties expire on July 1 they will be permitted to be renewed. Two hundred lessees will be benefited. Under the present Primos schedule, lessees are paid \$12 per unit for ore containing up to 44%, and 50c. additional for each additional 1% of tungstic acid up to 60%.

CHAFEE COUNTY

A copper-bearing sandstone, in the Badger Creek district, a few miles east of Salida, is attracting much attention. The formation has been seen for years, but never prospected. The Badger Creek Copper Syndicate (J. Hamilton, D. H. Craig, S. V. V. Zabriskie, and others), have shipped a carload of ore.

GUNNISON COUNTY

The Pittsburg mine in lower Russell gulch continues to be the largest producer of high-grade ore in the county. The vein shows persistence with depth. The Iron City mill recently treated 4 cords (36 tons) of ore for 16 tons of concentrate containing 1.62 oz. gold and 4.38 oz. silver. Two shipments of ore assayed 1.07 and 7.57 oz. gold, 8 and 10 oz. silver, and 7.35 and 7.59% copper.

In Leavenworth gulch the Bezanet mine has a good streak of pitchblende (radium ore) on the 160-ft. level. It is expected soon to cut the uranium belt. Some copper-iron ore, containing 10 oz. gold per ton, also occurs on this level.

IDAHO

BLAINE COUNTY

The Federal Mining & Smelting Co., which recently acquired the North Star-Triumph mines, near Hailey, has begun the erection of a 300-ton daily capacity concentrator at the prop-

erty, according to Frederick Burbidge of Wallace, general manager for the Federal company. The plant will be equipped with a flotation annex and electric separator, and is being designed and fitted especially for treatment of the North Star-Triumph ores.

LEMMING COUNTY

(Special Correspondence).—Development by hand has been discontinued at the Goldstone mine at Baker, and machine-drills are working in the lower workings, where it is expected that the upper ore-shoots will be cut. In the meantime the mill is being re-modeled. H. F. Riebling is manager.

Baker, June 23.

OWYHEE COUNTY

The well-known De Lamar mine near Silver City has been sold to J. B. Duncan, W. R. Heim, and others. The manager, E. V. Orford, has formally turned over the property to the new owners. The property will be worked under a leasing system.

SHOSHONE COUNTY (COEUR D'ALENE)

The sale of the Independent mine, near Kellogg, to P. Gearon and others for \$300,000, is considered one of the most important for some time. Machinery for 600-ft. depth has been ordered. A wide lode shows on the surface.

Thirty-six tons of ore, assaying 285 oz. of silver, and 9% lead, recently returned \$3001 net to the Big Creek Leasing Co. of Kellogg. Prospects for more rich ore are good.

Large reserves have been developed in the Federal company's Morning mine at Mullan, and the daily output is to be increased from 1000 to 1500 tons.

The Bunker Hill & Sullivan company, at Kellogg, which has a lease on the Alhambra mine, is erecting a mill of 25-ton capacity. The mine has been opened by three adits.

At the National copper mine there are 60 men employed. The mill is worked five days per week. Ore on the 1200-ft. level is of better grade than on the upper levels.

For the sum of \$111,200 the Nipsie Mining Co. has sold its property to the Interstate-Callahan company. The claims are north of the new owner's mine.

The Constitution Mining & Milling Co., of which Judge George Turner, former United States senator from Washington, is president, has decided to build a mill on its property, the Constitution group, near Kellogg. The plant will be of 100 tons' daily capacity, and will cost between \$30,000 and \$35,000. The Constitution ore is complex lead-silver-zinc, and for the last three months the management has been making tests to determine the best concentrator that would be required to treat the ore. A mill-site has already been selected 1000 ft. from the main workings, at a point where adequate water can be secured from Pine creek and a small tributary stream.

Pine Creek notes are as follows:

In the lower adit of the Douglas mine of the Anaconda company the ore-shoot is 3 ft. wide and 850 ft. long. The adit 170 ft. above is also in good ore. Average metal-contents are 28% zinc, 12% lead, and 8 oz. silver per ton. A hoist and compressor are to be installed for shaft-sinking.

The Highland-Surprise mill is crushing 40 tons daily, and is being doubled in capacity. There are 50 men employed.

Regular shipments of zinc ore are being dispatched from the Constitution.

The Star Antimony mine has yielded 25 to 30 tons of 55% antimony ore during the past few weeks. The mine is developing well. The Star ore is hand-jigged, there being three machines, two running steadily. Water for the jigs is supplied by pumping it from the creek 700 ft. below, through a 2-in. pipe. The hill is steep and the ore is delivered at the wagon-road on a go-devil. It is the plan of the company when No. 3 adit is extended under the present workings to make a raise to No. 2, when all the ore will be taken out through No. 3. A gravity tramway will then be constructed that will deliver the ore from that level to the wagon-road, and this will

meet the requirements until a fourth adit opens the property at the lowest practical depth. Fourteen men are employed, working three shifts.

Other properties on the Creek report encouraging results. Near the Star mine a post-office and store have been opened.

A 300-ton flotation annex will be working within 60 days at the Interstate-Callahan mill. It will treat concentrate and re-treat accumulated tailings. Mill feed averages 28% zinc and 6% lead. A very favorable ore contract has been made with smelters.

The Vienna-International Mining Co.'s lead mine on Placer creek, 6 miles from Wallace, closed since 1910, is to be reopened by F. C. Bailey and others of Spokane. R. Mack is superintendent.

MICHIGAN

THE COPPER COUNTRY

The Calumet & Hecla and subsidiaries are paying employees an additional bonus of 25c. per day.—Under certain conditions the Court has denied restraint of sale of the Tamarack, as asked by G. M. Hyams.

MISSOURI

JASPER COUNTY (JOPLIN)

The ore market last week was peculiar. Choice products were just as firm as in the previous week; intermediate grades were weaker and brought \$2 to \$3 per ton less; inferior grades were stronger and brought \$5 more than the previous week. The decline in spelter to 11.75c. helped bear the ore-market, which under ordinary conditions would have been strengthened through the fact that production was considerably curtailed by heavy rains, according to the *News Herald*. Calamine found a ready market at \$52.50, for 'jag' lots, up to \$55 for carload lots at Joplin, and \$65 for carload lots at Granby, basis of 40% metallic zinc. Lead ore was \$3.50 weaker per ton, selling for \$77.50. The Missouri-Kansas-Oklahoma output was 6040 tons of blende, 194 tons of calamine, and 1037 tons of lead, averaging \$78, \$53, and \$76 per ton, respectively. The total value was \$564,495.

The output for the first half of the present and past years is as follows, according to the *Globe*:

	1916	1915
Blende, pounds	349,724,764	226,472,350
Blende, value	\$16,842,369	\$9,221,951
Calamine, pounds	18,745,720	21,973,102
Calamine, value	\$698,408	\$462,469
Lead, pounds	54,119,082	40,420,100
Lead, value	\$2,422,349	\$1,025,982
Total value	\$19,963,126	\$10,710,502

MONTANA

LINCOLN COUNTY

According to E. G. Mellander of Libby, a San Francisco firm is to construct a dredging plant at a cost of \$410,000. Gravel is 22 ft. deep to bed-rock. A steam-shovel will load the gravel to a car, which is lifted and discharged to a 4 by 28-ft. revolving screen. The fine material passes through sluice-boxes, and the boulders go to the dump.

SILVERBOW COUNTY (BUTTE)

According to *The Anode*, published by the Anaconda company, conditions at the Washoe smelter are steadily improving. With the completion of improvements under way, copper conditions will be considerably exceeded in the near future. Two steam, oil-burning locomotives have been added to the local tramming and weighing department equipment. The men who are to handle these engines have taken the examination, and as soon as the large storage-tanks are completed the supply of fuel-oil will be ready and the new engines assigned to service on the hot-metal run. The addition of this power will greatly increase the efficiency of the local tramming depart-

ment. The new change-house, under construction near the oil-flotation plant, is nearing completion. It will be a model of convenience, fire-proof in every particular equipped with steel lockers, sanitary wash-bowls and shower-baths. The building is of brick, concrete, and steel construction. The light colored brick used—the product of tailing from the oil-flotation plant—are laid in dark-brown mortar with recessed joints, giving the building an artistic appearance. The research laboratory, also under construction, will soon be completed. This structure will be up-to-date in every particular, and will embody many new features in laboratory practice. There was a marked decrease in incapacitating accidents during the month of May. This may be attributed to the improved condition in a number of departments in which heavy construction work and other alterations have been completed. When the plant reaches normal working condition, the record already established for a low accident rate, no doubt, will be lowered materially from the present record.

At the 1600-ft. level of the Butte & London two 20 by 65-ft. stations have been cut. Two 1250-ft. cross-cuts are now to be driven to cut 20 veins running east from Anaconda hill.

NEVADA

CLARK COUNTY (GOODSPRINGS)

In the Goodsprings zinc-lead district there are now over 40 producers, averaging over 5000 tons per month, employing over 1000 men. The town is growing steadily.

ESMERALDA COUNTY (GOLDFIELD)

Daily shipments from the Jumbo Extension are 150 tons, averaging above \$30 per ton. Over a week's dispatches averaged \$42 per ton. Some lower grade dump ore has also been marketed. Development continues satisfactory.

HUMBOLDT COUNTY

Plans are completed and work begins at once on the enlargement of the Rochester Mines mill to 180 to 200 ton capacity. The announcement is made by L. A. Friedman, president and general manager. The additional equipment is made necessary by the increased ore reserves in the mine at Rochester.

A new mill, to cost in the neighborhood of \$100,000, is being planned for the near future by M. Bylesby & Co. of Chicago, purchasers of the Ragged Top tungsten claims, heretofore known as the Beeson property. They will receive custom ores. Headquarter offices are at Lovelock. During the 60 days the new owners have been working the property they have extracted and shipped 550 tons of ore. Thirty-five men are employed. The mill will be erected at Toulon on the Southern Pacific, an 11-mile haul.

According to J. Q. Brown, manager of the Nevada Valleys Power Co., the increase in use of electricity in the Lovelock valley and mining districts is 400% greater than a year ago.

A mill is probably to be erected by the Chicago-Nevada Tungsten Co. at Toulon on the Southern Pacific line, 20 miles south-west of Lovelock. The plant will be on the shore of Humboldt sink, the only available water-supply.

At National, of which little is heard nowadays, the National mine is producing gold regularly. Development on the Indian Valley claim adjoining is satisfactory; so is that at the No. 2. On the south end of the Auto Hill property Maney brothers are opening antimonial-silver ore. Mines at Buckskin are giving good results, but treatment facilities are lacking.

At a depth of 1650 ft. the main vein of the Silver-Tough Coalition has been cut in the Bird winze. The value across 18 in. is \$300 gold per ton.

LINCOLN COUNTY

The Comet district, out from Pioche, is attracting attention on account of its gold, silver, lead, and tungsten deposits. Lack of easy transportation militates against rapid work. A few trucks are to be used. The Silver-Comet company has a 100-ft. at work in charge of E. D. Smiley.

this tram could be used to advantage by the United States army.

UTAH

JUAN COUNTY

On account of the embargo of the smelters the Iron Blossom company at Tintic has 500 tons of ore tied-up in cars at Silver City.—The Eagle & Blue Bell can only send 50 tons daily to the smelter.—Steady work continues at the Gemini and Bullion Beck.

SALT LAKE COUNTY

Work is to commence during July on a 2500-ton leaching plant for the Utah Copper Co. The capacity will gradually be increased. About 40,000,000 tons of 1% ore is available for treatment. E. A. Wall has transferred his three-quarter interest in the Kangaroo claim at Bingham to the company in consideration of \$30,000. The ground will be used for dumping purposes. It was originally the basis of a big damage suit, and the transfer settles the litigation between Wall and Utah Copper that has been waged for years. The company's mills are now treating over 30,000 tons of ore daily, with a copper yield at the rate of 17,000,000 lb. per month.

Development in the South Hecla, in the Little Cottonwood, continues good. Shipments last week were 300 tons averaging \$25 to \$30 per ton.

Driving of the 4000-ft. 7 by 9-ft. drainage and transportation adit by the Wasatch Mines Co. in Little Cottonwood has been started. Two 480-cu. ft. I-R. compressors will supply air. Exploration of a large area will be facilitated by this work.

On June 20 the Utah Copper Co. loaded 41,800 tons of ore at the mine at Bingham, a record. The daily tonnage treated in June is approximately 34,000. It is said that plans are to be prepared to increase the mills to 50,000 tons per day.

SUMMIT COUNTY

The Big Four Exploration Co. at Park City has over 100 men on additions to its tailing plant, which is being enlarged to 750 tons per day. A steam-shovel has been ordered to facilitate handling the tailing.

Sub-lessees at the American Flag mine are extracting \$40.91 gold-silver ore from the 500 and 700-ft. levels. Some ore contains up to 40.5% lead. The Park City Mines Co. is the lessee.

WASHINGTON

For the first 6 months of 1916 the mines of Washington promised increased production in the five important metals for the year. The industry generally seems to be in better condition than for several years past.

FERRY COUNTY

(Special Correspondence.)—The Republic Consolidated Mines Corporation is employing 40 men in the Lone Pine mine, shipping 200 tons of good ore per week. The company proposes to extend a drive into the Pearl ground on the Pearl-Surprise vein.—The Knob Hill mine is yielding 100 tons of ore per week, with five machine-drills and 20 men. A new compressor has been installed in place of the old one, recently damaged by fire.—The San Poil mine is employing 22 men on the first and second levels, and dropping the ore to the adit-level for exit to the shipping bins. The company is planning to sink the main shaft deeper.—Work has been temporarily suspended in the adit on the Copper Butte mine, Orient district, because of trouble with the compressor.—The Laurier Mining Co., Orient district, proposes driving an adit for lower working and cheaper ore extraction. The mine is producing and shipping a good grade of copper ore.

It is reported that the miners of Republic will strike for \$4 per day, in place of \$3.50, as now paid. On June 22 the Republic Mine Operators' Association was organized, with S. H. Richardson as chairman and D. M. Drumheller as secretary. There are between 110 and 125 men employed.

Republic, June 24.

PERSONAL

Note: The Editor is not responsible for the accuracy of the work and appointments of persons mentioned in the text.

GEORGE W. PEIRCE is at New York.

T. W. GRUTTER is at the Empire hotel, San Francisco.

C. B. LAKENAN is here from Ely, Nevada.

H. C. PERKINS and HENRY JENNINGS are at Treadwell, Alaska.

EDWIN E. CHASE and son have gone from Denver to Butte for two weeks.

WILLIAM MOTHERWELL has returned to Colorado Springs from Pachuca, Mexico.

ROBERT A. KINZIE has gone to Juneau and will be in that region for about six weeks.

GLENN L. ALLEN passed through San Francisco on his way from Salt Lake City to Bisbee.

SAMUEL FISCHER has been appointed assistant foreman at the Great Falls smelter of the Anaconda company.

GEORGE E. FARISH, of New York, has moved his western office from Denver to the Nevada Bank Bldg., San Francisco.

VALERIUS MCNUTT & HUGHES, petroleum and mining geologists, have moved their Oklahoma office to the Mayo building, at Tulsa.

VICTOR C. ALDERSON, formerly president of the Colorado School of Mines at Golden, was recently in the Winnemucca district, Nevada.

E. W. BULLARD, safety engineer of San Francisco, is spending two months studying the manufacture and use of safety equipment in the Eastern mining districts.

MALCOLM MACLAREN is now returning to London by way of Siberia, having completed his geological investigations in Korea. He is due in London about the middle of July.

N. C. WHITTEK, foreman in the oil-flotation plant at Great Falls, Montana, has resigned his position to go to Peru, where he will be connected with the Cerro de Pasco Copper Company.

CARL J. TRAUERMAN has resigned the position of mill-superintendent to the August Mining Co., at Landusky, Montana, and is inspecting the Beaver Creek mines at Zortman, in Montana.

BERNARD MACDONALD has moved his office from Los Angeles to the Mills building, El Paso. With the Alvarado Mining & Milling Co. he is designing an increase in capacity of its mill at Parral, Mexico.

THOMAS WOLFSON, vice-president of the United Metals Selling Co., and president of the Raritan Copper Works, Perth Amboy, New Jersey, was recently on a brief visit to Great Falls, Montana, for the first time in 27 years.

L. L. WITTICH, for several years correspondent of the Press and several other well-known journals for the Joplin district, Missouri, and mining editor of the *News Herald* at that centre, died on June 26 at the age of 34, leaving a wife and two children. Mr. Wittich was one of the best informed of writers on matters pertaining to the zinc region of south-west Missouri.

The American Institute of Electrical Engineers of New York with its 32 sections and 51 branches throughout the country, has a membership of 8212. This is a net increase of 158 during the year ended April 30, 1916. The revenue was \$111,199, and expenditure \$109,999. The surplus is \$614,913. John J. Carty is president. The Institute has its quarters with other engineering societies in the United Engineering building, New York, and with them is aiding the Government in its national preparedness scheme.

THE METAL MARKET

METAL PRICES

San Francisco, July 5.

Antimony, cents per pound.....	15
Electrolytic copper, cents per pound.....	29
Pig lead, cents per pound.....	7.25—8.25
Platinum: soft metal, per ounce.....	\$75
Platinum: hard metal, 10% iridium, per ounce.....	\$79
Quicksilver: per flask of 75 lb.	\$80
Spelter, cents per pound.....	15
Tin, cents per pound.....	13
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, July 5.

Antimony: 50% product, per unit (17 or 20 lb.).....	\$1.00
Chrome: 40% and over, f.o.b. cars California, per ton.12.00—14.00	
Manganese: 50% product, f.o.b. cars California, ton.12.00—20.00	
Magnesian: crude, per ton.....	7.00—10.00
Molybdenum: 50% and over, per pound.....	0.60—1.15
Tungsten: 60% WO ₃ , per unit.....	25.00—35.00

New York, June 28.

Antimony: The nominal quotation is \$2 per unit, but there is little doing. It is reported that ocean-freight arrangements are more difficult to make, and that South American ore is not easily obtainable.

Tungsten: Inquiry is a little more brisk, and several small deals have been put through at \$30 to \$32 per unit, spot delivery. More business probably could be done were it not that the owners of the concentrate are holding for \$35 to \$40. It is expected that the market will be more active in July, when the makers of tool-steel and ferro-tungsten will seek their second-half requirements.

EASTERN METAL MARKET

(By wire from New York.)

July 5.—Copper is dull and unchanged; lead is steady but quiet; spelter is neglected.

Owing to a mistake, some of the June 24 prices were given for those of the issue of July 1; the averages for the latter have been corrected.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending				
June 28.....	66.25	May 23.....	74.14			
" 29.....	65.87	" 31.....	70.81			
" 30.....	65.90	June 6.....	66.35			
July 1.....	65.00	" 13.....	64.58			
" 2 Sunday.....		" 20.....	63.62			
" 3.....	65.00	" 27.....	65.49			
" 4 Holiday.....		July 5.....	65.16			
" 5.....	63.87					
Monthly averages						
	1914.	1915.	1916.			
Jan.	51.58	48.85	56.76	July	54.90	47.52
Feb.	57.35	18.15	56.74	Aug.	51.25	47.11
Mar.	58.91	50.61	57.89	Sept.	50.75	48.77
Apr.	58.52	56.25	61.37	Oct.	51.12	49.40
May	58.21	49.87	74.37	Nov.	49.12	51.88
June	56.13	19.02	65.01	Dec.	49.27	55.31

Advice from London states that China and Indian sales are the cause of weakness in silver, but from a statistical point of view the future is favorable.

A shipment of silver from San Francisco to China on June 28 was worth \$222,000, say 352,000 ounces.

TIN

Prices in New York, in cents per pound.

Monthly averages							
	1914	1915	1916		1911	1915	1916
Jan.	37.85	31.40	41.76	July	31.60	37.38	
Feb.	39.76	37.23	42.60	Aug.	50.20	41.37	
Mar.	38.19	48.56	50.56	Sep't.	33.10	35.12	
Apr.	36.10	48.55	51.49	Oct.	29.10	22.00	
May	33.29	29.28	19.10	Nov.	33.51	39.50	
June	39.72	19.26	42.01	Dec.	23.60	38.71	

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the

open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.		Week ending			
June 6.....	72.50	June 20.....	68.00		
" 13.....	68.00	July 5.....	80.00		
Monthly averages					
1914.		1915.		1916.	
Jan.	39.25	51.90	32.00	July	37.50
Feb.	39.00	60.00	29.00	Aug.	80.00
Mar.	39.00	78.00	21.00	Sept.	76.25
Apr.	38.90	77.50	141.60	Oct.	53.00
May	39.00	75.00	90.00	Nov.	55.00
June	38.60	90.00	74.70	Dec.	53.10

New Idria will pay \$1 per share on June 30.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending					
June 28.....	26.75	May 23.....	29.04			
" 29.....	26.30	" 31.....	28.25			
" 30.....	26.50	June 6.....	28.00			
July 1.....	26.50	" 13.....	28.00			
" 2 Sunday.....		" 20.....	27.17			
" 3.....	26.50	" 27.....	27.25			
" 4 Holiday.....		July 5.....	26.54			
" 5.....	26.50					
Monthly averages						
Jan.	1914.	1915.	1916.			
Jan.	14.21	12.60	14.30	July	12.26	19.09
Feb.	14.46	14.38	16.42	Aug.	12.34	17.27
Mar.	14.11	14.80	16.65	Sept.	12.02	17.69
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90
May	13.97	18.71	29.02	Nov.	11.75	15.88
June	13.60	19.55	27.47	Dec.	12.75	20.67

Anaconda has declared a dividend of \$2 per share; North Butte, 75c; and Mohawk, \$10.

From January 1, 1915, to March 31, 1916, Braden sold 46,822,116 lb. of copper at 19.556c. per lb. The net balance after paying for operation and interest, etc., was \$2,249,577.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.			Average week ending				
June 28.....		6.80	May 23.....		7.37		
" 29.....		6.85	" 31.....		7.25		
" 30.....		6.85	June 6.....		7.15		
July 1.....		6.85	" 13.....		6.90		
" 2 Sunday.....			" 20.....		6.77		
" 3.....		6.85	" 27.....		6.78		
" 4 Holiday.....			July 5.....		6.84		
" 5.....		6.85					
Monthly averages							
Jan.	1914.	1915.	1916.	Jan.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	Aug.	3.86	4.67	
Feb.	4.02	3.83	6.23	Sept.	3.82	4.62	
Mch.	3.94	4.04	7.26	Oct.	3.60	4.62	
Apr.	3.86	4.24	7.70	Nov.	3.68	5.15	
May	3.90	4.24	7.58	Dec.	3.80	5.34	
June	3.90	5.75	6.88				

On July 3 the Bunker Hill & Sullivan paid two dividends of \$81.750 each. The total to date is \$17,754,000.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
June 28.....	11.75	May 23.....	15.27
" 29.....	11.62	" 31.....	14.52
" 30.....	11.50	June 6.....	13.20
July 1.....	11.25	" 13.....	13.64
" 2 Sunday.....		" 20.....	12.50
" 3.....	11.25	" 27.....	12.12
" 4 Holiday.....		July 5.....	11.40
" 5.....	11.50		
Monthly averages			
1914.	1915.	1916.	
Jan.	5.14	6.30	18.21
Feb.	5.22	9.09	19.99
Mar.	5.12	8.10	18.10
Apr.	4.98	9.78	18.82
May	4.91	17.46	16.01
June	4.81	22.20	12.85
July			
Aug.	4.75	20.54	
Sept.	5.16	14.14	
Oct.	4.75	11.05	
Nov.	5.01	17.20	
Dec.	5.30	16.75	

Zinc ore at Joplin, Missouri, averaged \$78.12 per ton for 60c product during June. The range was from \$60 to \$90.

The reduction of 8c. per lb. on three of the New Jersey Zinc Co.'s brands, mentioned here last week, referred to oxide products. On July 10 the company pays 10c. and on August 10, 1c. dividends. Including these, the disbursements this year total \$52 per share, equal to \$18,200,000.

Eastern Metal Market

New York, June 28.

Copper continues dull, with second-hands making what market there is.

Zinc has continued to decline, and the trade is wondering when the present trend will be checked.

Lead had a better tone based on moderate export buying last week, but it has turned easier again. The present level of prices is dependent on renewed foreign buying.

Tin is lower, with the supply unusually large. Banca tin offerings at concessions have helped to upset the market.

Antimony shows no improvement, and its price is lower.

Aluminum is weaker by 1c., following a lighter demand.

With the urgent war buying past, and new buying for the belligerents conducted on a conservative basis, there are many reasons for considering that extremely abnormal war prices have gone for good. The question now is, at what point above normal levels will prices settle? In the metals, as in many other commodities, it is beginning to be realized that prices which are far in excess of values tend to strangle business. In steel-construction work, for instance, many ventures of an investment nature are being indefinitely postponed because between 2.50 and 3.50c. per lb. is asked for structural shapes. All building materials are proportionately high.

Export buying of steel and pig iron is a supporting phase of the situation, while the prospect of large Government purchases of steel is another. The strike of iron miners in the Lake Superior district is growing in proportions, and may have a serious effect on the ore market. There are also fears that the transportation facilities may be inadequate to carry the season's output.

COPPER

The market continues very dull and weak, with scarcely enough drift to show the exact level at which any considerable business might be done. Such prices as are quoted are those established by the offerings of second-hands. Electrolytic can be had today without difficulty at 26.50c. cash, New York. The purely nominal price of Lake is 27.25c. cash, but it is so neglected that one price is about as good as another. That the producers are not looking for business at reduced prices is evidenced by the fact that most of them are holding to 29.50 to 29.75c. for August, whereas second-hands would be glad to sell at 26.50 to 27c. The brass mills are shading their quotations for brass rods, indicating that they are catching-up on deliveries. Brass sheets are still difficult to procure inside of six or eight weeks. Copper sheets are easier to get than they were a few weeks ago, the price being 37.50c., and some of the mills are looking for future business. Of course, all have enough to keep them busily employed for many weeks to come. The foreign demand for finished brass and copper products is fair, but not to be compared with that of even a few weeks ago. The London quotation for electrolytic yesterday was £130. Exports, June 1 to 27, totaled 29,256 tons. In the first four months of this year the exports of brass products, such as bars, plates, etc., totaled 29,591 tons, against 11,281 tons in the same period of last year. The National Brass & Copper Tube Co., commenting on the market, in its house organ, *Copper Gossip*, says:

"Business in copper is on a much more moderate scale than a few weeks ago, and apathy regarding the situation, on the basis of current quotations, gives evidence of the change in tons. The diminishing rate of activity is not surprising, however, after the aggressive buying earlier in the year when considered in connection with the hesitation over the outlook. The enthusiasm that accompanied the remarkable buying movements of a few months ago has evaporated. There is

more conservatism in all quarters. The impression in influential circles is that the price advance has been over-done, and that a more normal market is necessary to impart confidence."

ZINC

The trend of prices continues downward, business is almost at a standstill, and authorities in the trade are frankly disappointed. A few weeks ago they thought the turn had come, when there was a little business during which prices advanced about 1/2c. Then quiet came again, and it has lasted without a break. The New York quotation yesterday was about 11.75c. for spot zinc, with St. Louis around 11.50c., but it is reported that at least one sale of a round lot was made at 11.37 1/2c., St. Louis. July can be had at about 11c., New York, and August at 10.50c. Students of the market do not believe that the bottom has yet been reached. They hold that the trade should be satisfied if the market steadied at or near the existing levels, provided buying became active. It is notable that the premium for brass-mill special has about disappeared and that it can be had at very near the quotation for prime Western. If the decline can be checked, good buying by the sheet galvanizers probably will ensue. Exports keep up fairly well, those of the month, including June 27, amounting to 4078 tons; but they are not sufficient to absorb enough of our output at the present time. In Great Britain, consumption is being cut down by the shortage of labor, while another influence detrimental to our producers is the sale abroad of Japanese spelter. The output of Japan is reported to have been considerably increased, and that of France also. Despite the disposition of the British government to assist smelting in England it is hampered by the difficulty of getting ore from Australia. In France, large quantities of prime Western, purchased in the United States, has been re-refined for brass purposes. The London quotation for spot yesterday was £65.

Sheet zinc is quoted at 18c., f.o.b. smelter, carload lots.

LEAD

The crux of the lead situation lies in the export demand. If it is good, quotations here probably will be maintained, but if it becomes light, prices almost to a certainty will decline. About the middle of last week several thousand tons were taken by foreign buyers and the market stiffened a little, rising from 6.62c., New York, to 6.85c., but after the activity tapered off the market weakened again, and yesterday independents were eager for business at 6.80c., New York, and 6.65c., St. Louis. The A. S. & R. Co., meanwhile adheres to 7c., New York, and 6.92 1/2c., St. Louis. The London spot quotation yesterday was £29 15s. Existing demand runs chiefly to desilvered lead, said to be superior for some munition's purposes.

TIN

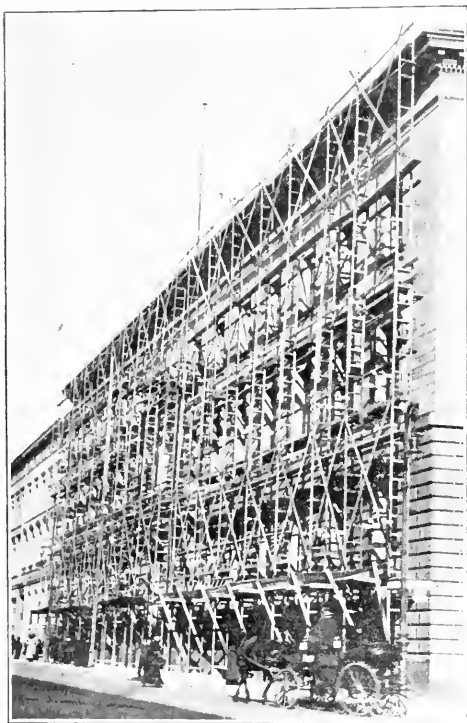
The market is weak and unsettled, partly because of the offerings of Banca tin at concessions of 1 to 1c. from the price for Straits, and because of the large arrivals. From June 1 to 27 these aggregated 5420 tons, with 2237 tons about. Fine deliveries into consumption promise to be large. There has been some quiet buying of futures by consumers, but not a great deal, and no real activity is expected until the market becomes steady. Spot Straits was quoted at New York yesterday at 39 cents.

ANTIMONY

Conditions are but little changed, and the market continues dull and listless. Lots of 5 to 10 tons can be had at 17.50c., with about 18c. asked for smaller quantities. Competition is so keen that the situation is in the buyers' hands.

Scrap Metals Recovered in 1915

The value of the copper, lead, zinc, tin, aluminum, and antimony recovered in the United States from scrap metals, skimmings, and drosses in 1915 was \$114,304,930, against \$57,039,706 in 1914, a 100% increase. The incentive of high



STRIPPING THE COPPER CORNICES OFF A BUILDING AT BERLIN.
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prices caused all metal wastes to be more carefully saved, segregated, and refined. The output of secondary metals was as follows: copper, including brass and alloys, 196,000 tons; lead, 79,000 tons; zinc, 92,575 tons; tin, 12,447 tons; antimony, 3102 tons; and aluminum, 8500 tons, all large increases over the recovery in 1911.

Manganese in 1915

Production of manganese ore in the United States in 1915 was 9651 long tons, the largest since 1901, and more than three times the production in 1914, which was 2635 tons. This output was made by 31 operators in 10 States, of which the four most important, in order of output, were Georgia, California, Virginia, and Arkansas, according to figures compiled by the U. S. Geological Survey. In addition, Alabama, Arizona, Colorado, Tennessee, Texas, and Utah produced small amounts of ore. Imports of manganese ore in 1915 were 313,985 tons, compared with 283,291 tons in 1914. Of the ore imported in 1915, 268,786 tons, or 85% of the total, came from Brazil—more than twice the quantity received from Brazil in any preceding year. Imports from India were 36,450 tons, or about one-fourth the average of the preceding 10 years. No ore was received from Russia.

The production of manganiferous iron and silver ores in 1915 was 798,404 tons, almost twice the output in 1914. Most of this ore was used in making high-manganese pig-iron, but a large quantity was used as a flux by lead smelters; 66,530 tons contained more than 15% manganese and a large part of this was used to make low-grade ferro-manganese.

The prices offered for manganese ore adapted to the manufacture of ferro-manganese rose during 1915 to the highest figures that have been recorded for 30 years. In August, Eastern alloy makers offered \$22.50 per ton for 50% ore, compared with \$12.50 per ton, the average price for the preceding five years. In March, 1916, it was reported that \$32.50 per ton was paid for such ore. This great rise in prices was due largely to the advance in ocean freights caused by the shortage of vessels in which to move imported ore. There is good reason for expecting a further increase in domestic production during 1916 as a result of the high prices offered, but it is doubtful whether more than 10% of the domestic demand can be met by domestic production.

The shortage of high-grade manganese di-oxide ores caused by cessation of exports from Russia has become a serious menace to the dry battery and flint-glass industries. Prices as high as \$85 per ton are freely offered, but as only a few deposits in the United States can supply ore of this grade, little domestic ore has come to the market. There is record of a marketed production of 550 tons from mines in Arizona, California, Colorado, Utah, and Virginia during 1915, whereas the annual demand ranges from 20,000 to 25,000 tons. Ore of this grade was imported from Japan and Cuba during 1915.

Gold and Silver Production in the United States

The Bureau of the Mint and the Geological Survey have issued the following joint statement as to the final figures on the production of gold and silver in the United States during the calendar year 1915:

	Gold		Silver	
	Fine Oz.	Value	Fine Oz.	Value
Alabama	247	\$5,100		
Alaska	808,346	16,710,000	1,054,634	\$526,100
Arizona	220,392	4,555,900	5,665,672	2,826,500
California	1,090,731	22,547,400	1,689,924	843,100
Colorado	1,089,928	22,530,800	7,199,745	3,591,900
Georgia	1,684	34,800	141	100
Idaho	56,628	1,170,600	13,042,466	6,506,800
Illinois			3,892	1,900
Michigan			581,874	290,300
Missouri			55,534	27,700
Montana	240,825	4,978,300	14,423,173	7,195,600
Nevada	574,874	11,883,700	14,453,085	7,210,500
New Mexico	70,632	1,460,100	2,387,064	1,165,900
North Carolina	8,258	170,700	1,496	700
Oregon	90,321	1,867,100	125,499	62,600
Philippine Islands	63,898	1,320,900	15,148	7,600
Porto Rico	34	700		
South Carolina	174	3,600		
South Dakota	358,145	7,403,500	197,569	98,600
Tennessee	329	6,800	99,171	49,500
Texas	87	1,800	724,580	361,500
Utah	189,045	3,907,900	13,073,471	6,522,200
Vermont			150	100
Virginia	24	500		
Washington	22,330	461,600	213,877	106,700
Wyoming	672	13,900	2,910	1,400

Total 4,887,604 \$101,035,700 74,961,075 \$37,397,300

At the average price of silver per fine ounce for the calendar year 1915, \$0.49889.

These figures compare with the production of 1914—\$94,531,800 in gold and 72,455,100 fine ounces of silver.

The mill capacity was increased from 3000 to 4000 tons per month by adding a 6-ft. Hardinge ball-mill, in place of a 4-ft. machine. The plant treated 35,999 tons, averaging \$7.51 per ton. There was extracted 11,979 oz. gold and 1455 oz. silver, with 92.4% recovery. All costs amounted to \$5.47 per ton, a reduction of 97 cents. The net profit was \$196,919.

BOOK REVIEWS

ENGLISH AND AMERICAN TOOL BUILDERS. By Joseph Wickham Roe. P. 315. Index. Yale University Press, New Haven, Conn. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, \$3.

This is a historical work, dealing especially with the careers of the great builders of tools. It is a presentation of the human side of the evolution of machine-tool design and construction, and cannot fail to interest members of the engineering profession who can appreciate the human as well as the materialistic side of their work. The European War has created an immense demand for machine-tools of every description.

CARTRIDGE MANUFACTURE. By Douglas T. Hamilton. P. 167. Index. The Industrial Press, New York. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, \$1.50.

SHELL MANUFACTURE. By Douglas T. Hamilton. P. 296. Index. The Industrial Press, New York. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, \$2.50.

The War has brought about what might be termed an industrial upheaval in the United States. The demands made upon the American manufacturer by the belligerents in Europe for munitions of all kinds in quantities beyond precedent have practically created in the United States a new industry over night. The manufacture of cartridges and other munitions is a highly specialized industry, calling for the use of special tools and jigs not ordinarily applicable to other lines of manufacture. The publication of Mr. Hamilton's works is especially appropriate since the American government seems fairly committed at this time toward a policy of preparedness. The engineering-society work in the preparation of an industrial census should make every manufacturer of iron and steel products in the United States interested in learning how he may adapt his own equipment to munition-manufacturing in case of emergency. These works are up to the minute and go thoroughly into detail in regard to all of the requirements incident to the manufacture of cartridges and shrapnel and should find a place in the reference library of every machine shop operator.

MODERN STARTING, LIGHTING, AND IGNITION SYSTEMS. By Victor W. Page. P. 509. Ill., index. Norman W. Henley Publishing Co., New York. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, \$1.25.

The strides that have been made in the development of the mechanical details of motor cars have been so phenomenal that it is difficult even now to say whether or no the last word has been said on the subject of starting, lighting, and ignition. Nevertheless, the opinion is general that these phases of automobile design have been fairly well standardized. It is a far cry from the simple coil and battery ignition that was one of the chief causes of perplexity for the pioneer motorist of a few years ago, to the nearly 100%-reliable lighting, ignition, and starting units in use almost universally on the motor car of today, regardless of price. The automobile has proved to be a great educator to the layman, insofar as the operation of the motor, transmission, and differential are concerned, but the electric features still remain to a greater or less extent, a sealed book to the average motorist. Here, then, is an opportunity for those interested to understand the why and the wherefore of the electrical section of the automobile power-plant, an opportunity that should be taken advantage of by every motorist. The book is well written, in such a way as to be readily understandable by the average man. It is replete with illustrations that will facilitate a ready understanding of the text.

MINING DECISIONS

QUARRY LEASE—ABANDONMENT

A 99-years lease of a granite quarry required an annual rental, not to exceed \$25 when the quarry was worked, and a nominal rental of \$1 per year when the quarry was not worked. The lessees failed to work it for 14 years, and then after a dispute with the lessor persisted in their refusal to work it for an additional three years. Held, this inaction on the part of the lessees constituted an abandonment of the lease entitling the lessor to cancel it in a suit to quiet title.

Ellis v. Swan (Rhode Island), 96 Atlantic, 840. March 22, 1916.

PLACER LOCATIONS OF PHOSPHATE ROCK

The act of January 11, 1915, authorizing the completion under the placer mining laws of placer locations of lands containing deposits of phosphate rock, applies only to placer locations upon which the assessment work has been annually performed; and the Land Department is without authority to extend the remedial provisions of that act to locations upon which annual assessment work has not been performed.

San Francisco Chemical Co. (Land Department), 44 Land Decisions, 356. August 26, 1915.

EXTRA-LATERAL RIGHTS BELOW JUNCTION OF VEINS

The Supreme Court of Montana on re-hearing, modified its previous decision in the Anaconda Copper v. Pilot-Butte case by awarding to the plaintiff an extension of the temporary injunction theretofore granted, so as to include the portion of an extra-lateral right below the junction of a discovery and a secondary vein, which was properly tributary to the secondary vein. Previous decisions that as against a hostile claimant who owns no part of either apex, the boundary planes of the senior vein will control the right below the point of junction were affirmed.

Anaconda Copper Mining Co. v. Pilot-Butte Mining Co. (Montana), 156 Pacific 409. March 29, 1916.

BOUNDARIES—MONUMENTS—EXTRA-LATERAL RIGHTS

The general rule that monuments mentioned in a description of land prevail over courses and distances written in a conveyance thereof does not permit of the curtailment of the 1500 ft. of vein and 20.45 acres of a lode claim plainly called for in the patent, to a vein length of 1364.5 ft. and proportionately smaller area bounded by some stakes found 19 years after the patent was issued and not mentioned or described therein, there being no conflict between the courses and distances and the monuments named in the patent, and the posts in dispute being described solely in the field notes of the survey. The amendment of 1904 to Section 2327 Revised Statutes held not applicable to land patented prior to that date. Where a locator seeks protection of the provision of law giving him an extra-lateral right within side-end lines where he has by mistake located his claim across instead of along his vein, he must establish by a preponderance of evidence that the vein in question was actually the discovered vein and the location made in error. He will not be allowed after a lapse of 25 years after patent to claim an extra-lateral right through his end-lines on the basis of the newly discovered fact that there was a cross-vein apexing some 400 ft. away from the original discovery cut and that no length-wise veins exist.

Cookling Mining Co. v. Silver King Coalition Mining Co. (Utah), 230 Federal, 553. February 12, 1916.



EDITORIAL

T. A. RICKARD, Editor



CARRANZA'S credit is measured by the sale of an ice-cream cone for \$2 in fiat currency at the bridge spanning the Rio Grande between El Paso and Juarez.

THE index for volume 112, January to June 1916, is now ready, and may be obtained by writing to this office. The number 112 indicates that this paper has passed its 56th birthday.

FROM consular reports and other sources of information, it appears that the amount of American capital invested in Mexico makes a grand total of \$1,250,000,000, out of which \$225,000,000 is invested in mines, \$26,500,000 in smelters, and \$175,000,000 in the oil business.

"INVESTING American lives to recover American money" is what the *Evening Scream* calls intervention. But the fire-brigade risks life to save property and so does the policeman who attacks an armed burglar. Most of us think it honorable to protect our property and our rights.

SINCE 1890 the purchasing power of a dollar has decreased 37%, but the purchasing power of labor has not decreased in the same proportion. The rise in wages is the economic recognition of the higher cost of living, due not only to the enhanced price of necessities but also to the expanding consumption of luxuries.

WHAT will happen to the Mexican employees of the copper companies in the South-West in the event of war is a question rightly asked at this time. The population of the United States includes 120,000 Mexican men of adult age, of whom 10% only are naturalized. The opinion of the mine managers is that there is little probability of their Mexican employees returning to the country of their origin in order to take up arms against us, because they were never so well paid as they are now and the political tangle has diminished any natural patriotic impulse.

FEELINGS engendered by the horrors of the War have caused many thoughtful men to break from their mental moorings. We note with regret that Mr. Francis W. Hirst has had to resign the editorship of *The Economist*, in many respects the most trustworthy and influential financial paper in the world. He has used his position to express his personal convictions in regard to the great struggle and its baleful consequences to such an extent as to impair his efficiency in the more prosaic work of a commentator on commercial affairs. He was a fearless

and able editor, of a kind rare anywhere. To mining matters he gave much useful and incisive criticism. We hope he may find scope for his unusual ability and high character in some other post of duty.

LOW costs of producing copper are being spoiled by the hurry to take advantage of the abnormally favorable market. During the 15 months to April 1, 1916, the cost at Braden averaged 9.67 cents per pound, as against the estimate, made in January 1915, of 6½ cents. However, the profit per ton is the main item in mining, not the cost.

DISCUSSION this week starts with a thoughtful defence of the stamp-mill by Mr. W. E. Cahill, who writes from a locality where the stamp-mill is being used on an enormous scale. This letter may be read in conjunction with the editorial article on 'Rolls and Ball-Mills v. Stamps' appearing in our issue of October 16, 1915. Mr. Henry S. Reed writes feelingly on the subject of Sunday labor and voices the views, we believe, of many of our readers. We are always glad to give space to matters of human, as well as technical, interest.

CALIFORNIA has a great variety of useful minerals, but the value of them is not enhanced by such ignorant advertisement as is given in our local press. On the front page of a recent issue of the *Morning Herald* we find a lot of childish nonsense about a discovery of barytes, or barite, that is to yield "poisonous volcanic vapors" and "promises to become a menace to the Kaiser's armies fighting in Russia." And all because barite is a sulphate from which, it is stated, sulphuric acid is to be made. As a matter of fact the chief uses of the mineral are in the manufacture of paints, the coating of linoleums and oil-cloths, enameling iron and steel, besides adulterating sugar and making poker chips.

COPPER smelting and refining is being considered as the subject of taxation, says our Washington correspondent. The proposed Tariff Commission is expected to take the matter in hand, the impost suggested being 1% on annual receipts between \$25,000 and \$1,000,000; 2% up to \$10,000,000; and 3% on \$10,000,000 or more. Under such taxation, a number of companies would pay \$1 per share per annum and others from 50 to 80 cents per share, but this would be less than the daily fluctuation in the stock quotation and could hurt nobody. The Calumet & Hecla would pay \$5.50 per share, when copper sold at 25 cents per pound.

but even that should not break the heart of a patriotic Bostonian.

WHAT the zinc market owes to foreign trade is suggested by the statistics of export. During the first six months of the current year 108,500 tons of spelter was exported, as compared with 111,000 tons during the corresponding period of last year and only 1500 tons two years ago. What profits have accrued from the rise in spelter is indicated by the dividends paid by the New Jersey Zinc Company, which has distributed \$52 per \$100 share on its capital of \$35,000,000 during the past 8 months. One shareholder has received \$1,675.128 and another \$1,566.448 in dividends, while three others have each received over \$900,000 (one might call it a million for short!) during the same period, and among them we are glad to see the name of Mr. J. P. Wetherell, to whom the metallurgy of zinc is so largely indebted.

ANACONDA makes a fine showing in the report for the twelve months to June 1. The net profit is \$14,363,881 after expending \$8,715,881 on improvements. What these improvements are and how they have increased the efficiency of this splendid metallurgical establishment was made clear to our readers recently in the articles by Mr. L. S. Anstin and in our own comment. Owing to the fact that Anaconda does a large custom and refining business, it is not the company's habit to give information concerning the cost of operations. It has been estimated that the total cost is 10 cents per pound of copper. Mr. John D. Ryan has been quoted as saying that he could make copper for 5 cents per pound for 5 years if he cared to gut the mines, but his policy is exactly the opposite of that, namely, to operate the mines so that the enterprise will approach the character of an investment. It is probable that a cost of less than 9 cents per pound of copper will be attained when all the improvements have come into effect. The company's mines at Butte have penetrated below 3000 feet in vertical depth without noteworthy impoverishment.

EXPLORATION among old workings continues to be the main feature of mining at Leadville. The first enterprise of this kind, that of unwatering the Penrose shaft in the Down Town area, was completed in June, after 13 months of continuous pumping to a depth of 874 feet. The search for ore can now proceed. The next scheme was to unwater the Harvard shaft in the Fryer Hill district. This is being done by the United States Smelting, Refining & Exploration Company, a subsidiary of the well-known corporation having a nearly similar name. Then the Empire Zinc Company began to drain the Wolfstone shaft and its surrounding territory. In our last issue our Leadville correspondent gave many details concerning the latest venture, that of draining and re-opening a large area through the Mikado shaft, which is 1206 feet deep. This venture promises to be the most important. It is interesting to note that motor-driven centrifugal pumps are being used with great satisfaction. Sudden rushes of water and debris

from old openings cause 'burn-outs' occasionally, but these have proved minor interruptions. The high price of lead and of zinc, and lately of silver, gave an impulse to the re-opening of these old properties, and even though, as is confidently expected, extensive orebodies are uncovered, a further drop in prices will much disappoint those by whom capital has been subscribed for these plucky undertakings. Later in the current year we may expect to hear something about the first fruits of development in these abandoned portions of a famous mining district. The Valley adit, which penetrates Prospect mountain, another exploratory scheme, has disclosed iron-silver-manganese ore, and promises well. The Arkansas Valley smelter is crowded with ore, the Western zinc-oxide plant is being enlarged, and many promising undertakings are in full swing, so that the future of Leadville seems brighter than for a decade.

The Mexican Fizzle

On another page we publish a long and interesting letter by the mining engineer who was our correspondent in the City of Mexico. He, like other Americans, had to flee the country when Messrs. Wilson and Carranza began their exchange of explosive notes last month. We commend his description of the state of affairs prevailing in Mexico; it serves to indicate the ineptitude and corruption of the Carranza government. Mr. H. Lane Wilson, formerly ambassador to Mexico, is a man for whose judgment we have no particular respect, as we believe that he contributed largely to the mistaken policy of Mr. Taft, when President, but we note with approval a recent remark reported to have been made by him: "We recognized a *de facto* government that has since become a *de jure* government." And sufficient proof of it is to be found in the note from Washington on June 20, in which the Secretary of State asserts that for three years "American lives have been sacrificed, American enterprises destroyed"; there has been committed "outrage after outrage, atrocity after atrocity;" and during "attacks on American territory Carranza soldiers took part in the killing, looting, and burning." Yet, during all this time, knowing all these things, the Administration at the head of our government has recognized that of Carranza and his followers. Finally, they were called to order, the civilian soldiery of the United States was called to arms, and a show of real resentment was made. Carranza replied by issuing insulting statements at his own capital, for domestic consumption, meanwhile postponing a formal reply to the peremptory demands from Washington. He released the Carrizal prisoners without disavowing the orders to General Trevino that caused that affair of outposts. Before he replied to the note, the punitive expedition under General Pershing had been withdrawn nearly to the frontier, without having accomplished its object; for Villa is again on the rampage, as impudent as ever. Carranza appears to have scored, for the American threat has rallied Mexican support to his side and di-

verted attention momentarily from the grim reality of famine; Mr. Wilson's consistent desire to preserve peace has been varied by a sharp note and a little preparedness, neither apparently meant to be taken too seriously. So the crisis passes into a fizzle. Don Venustiano Carranza has made good his bluff. We are where we were; in that limbo of indecision called 'watchful waiting.' *Mañana* continues to epitomize the policy of the Administration. Again the relations of the United States and Mexico are in a state of flux; they drift on the logic of events, which is a current that flows just as decisively in a definite direction as the meanderings of the chief protagonists trend nowhere in particular. It is reported that the State Department will not hold itself responsible for the safety of any Americans remaining in Mexico. Is that to hold good indefinitely? If not, until when? Is the \$1,250,000,000 of American capital to be jettisoned until such time as Señor Carranza and his 'constitutional' friends restore order? Apparently, that is the idea; no chance of friction with those amiable gentlemen is to be risked by mentioning such little matters as the railways, oil-wells, and mines legally owned by Americans in Mexico. The United States has no moral right to interfere in a foreign country to defend its nationals resident there or the property they own there; so say the pacifists now dominant at Washington. The adventurer or concessionaire must take his chances; his country washes its hands of him. So? Yet we hear that the Administration is in consultation with New York bankers with a view to furnishing financial aid, that is, lending money, to the bankrupt government of Carranza. Is the loan to be protected by the United States or is it to share the fate of the equally honorable capital already expended in Mexico by mine operators, for example? What is the distinction? Of course, if any large sum is loaned by the banks, it will be on good security and that security will be the backing of the Government of the United States, and, what is more, the assurance that the Administration will take measures to protect the bankers' mortgage on Mexico. Meanwhile, the border will be patrolled by a large force, the boundary being 1300 miles long, with chances for complications continually present. Later, we shall have trouble with the European governments, when they have time to attend to this little affair, because they surely will not consent to the despoiling of their nationals, even if we are willing to see our own driven out of the country and dispossessed of their property. The problem will have to be faced; no 'watchful waiting' will solve it; it is a condition and not a theory that confronts us in Mexico, and no professorial philosophy can wave aside the brutal fact. The Mexican tangle can be made smooth in two ways: either the Carranza party will restore order and constitutional government, or the United States government will intervene, by consent or by force, for that purpose. No promise of either is evident. In the note of June 22 addressed to the representatives of the Central and South American republics, Mr. Lansing stated that even if hostilities ensued "this Government had for its object

not intervention in Mexican affairs but the defence of American territory from further invasion by bands of armed Mexicans, etc." Thus the Administration has pledged itself not to intervene, in the sense of helping or enforcing the restoration of order in Mexico. However, this pledge is not binding on the next Administration, and there lies the hope of ending this miserable farce. But whatever Mr. Wilson or Señor Carranza may do, or not do, one thing is certain: the 'rough house' in Mexico cannot endure. Our correspondent speaks of the spread of famine and of other factors that are bringing the country to utter misery and ruin. If we had a humane reason for going into Cuba—and we had it—we have many of them for going into Mexico. But apart from a condition that may be remedied, there is a greater force at work moulding the relations of the United States and Mexico. When President Roosevelt acquired the Panama Canal zone he flung the strategic frontier of the United States 1500 miles southward. To that latitude the United States will grow, not by annexation, let us hope, but by exercise of beneficent control. From the Great Lakes to the Panama Canal the United States is destined to exercise some sort of suzerainty. This fact must be faced by any man claiming to be a statesman, in the White House or at the National Palace.

Calumet & Hecla

On July 15 this great copper mining company celebrates its semi-centenary, having begun operations in 1866. The celebration arranged by the local management is meant to make the day memorable to the 5000 employed on the mine. Mr. Rodolphe L. Agassiz, president of the company and the son of Alexander Agassiz, the naturalist, who was superintendent of the mine in 1865, will share the honors with Mr. Timothy O'Shea, who has worked at the mine for 50 years and six months, having helped to dig the original pit excavated at the place of discovery. The actual discovery of the lode is to be credited to Edwin J. Hulbert, a local surveyor and a keen student of geology under such men as W. H. Stevens, Samuel W. Hill, and Charles Whittlesey. In 1858 he was surveying a State road from Copper Harbor to Ontonagon when he noticed a violent deflection of the magnetic needle in Section 23 (T. 56, R. 33), near where Hecla No. 1 shaft was sunk subsequently. He found fragments of a brecciated conglomerate containing native copper, resembling 'float' that he had seen several years earlier on the banks of the Eagle river. At this time he uncovered, on Section 14, an 'ancient' Indian pit, similar to others previously found on the Keweenaw peninsula. Upon examining the map he ascertained that the discovery was on Government land, whereupon, in February 1860, he acquired a tract of 1920 acres, so located as to cover the ground he intended to explore for the lode, not yet disclosed. The Civil War, his own illness, and other hindrances prevented him from doing anything until 1864. We have the testimony of the late James D. Hague, who was then manager of the Albany & Boston

mine in the same district, that Hulbert was convinced, by the behavior of the magnetic needle, that a strong lode existed in this part of the country. He even showed his note-book to Hague, indicating the most likely locality. A few months later the first exposure of the Calumet conglomerate was made, beneath a covering of soil and drift 8 feet thick, in a pit dug at a spot indicated by Hulbert himself. On September 17, 1864, his brother John and Amos H. Scott, working under his direction, cut through the amygdaloid forming the hanging wall of the lode, into the copper-bearing conglomerate on Section 13. A barrel of the ore was sent to Boston on November 15, 1864. Earlier in the same year, by aid of the late Horatio Bigelow, he had formed the Hulbert Mining Company for purposes of exploration. In this company he held a quarter interest, 5000 shares. In December the Calumet Mining Company, also with 20,000 shares, was organized to acquire the land in Section 13, and in the same month the Hecla company was formed, with another 20,000 shares. In the spring of 1865 he went to Boston, where he arranged with the late Quincy A. Shaw for the loan of \$16,800, wherewith to buy more land, which was deeded to the Calumet company. He received 5833 shares, making his holding 10,833 shares. Meanwhile the 'ancient' pit on Section 14 proved to be an Indian 'cache' or hiding-place, in which birch-bark baskets and a lot of oxidized copper was unearthed, but on sinking through the floor of this pit the lode itself was cut in February 1866. This was on ground belonging to the St. Mary's Mineral Land Company, and Hague endeavored to assist him in purchasing a large tract for \$100 per acre, but his friends in Boston thought the evidence of mineral wealth too scanty, so the deal was not made and Hulbert made his arrangements with Bigelow and Shaw. Section 23, a square mile or 640 acres, which became the Hecla property, was bought early in 1866 from the St. Mary's Mineral Land Company for \$60,000. The rest of the property, as then acquired, cost about \$100 per acre. Some of the first ore produced from the prospect-holes was milled at the Albany & Boston, where it yielded 14.5% 'mineral,' equivalent to 12% ingot copper.

It is fortunate that we have the testimony of such a scientific witness as James D. Hague on these historic events, besides the written record of the discoverer himself. Therefore there is no question that to Edwin J. Hulbert belongs the credit for the discovery of the Calumet & Hecla, and also for the exploratory work that led to the event. It may be added that the present writer was able to discuss the subject with Mr. Hague 12 years ago, and he also corresponded with Mr. Hulbert, at that time in retirement at Rome. In 1866, the shares of the Calumet company rose to \$75, but before the profit-making stage was reached there were many delays and much disappointment, causing financial embarrassment to Hulbert, among others. What with assessments and loans, about \$1,200,000 was required before the mine was placed firmly on its feet and in the interval the original owners of the enterprise were put to a severe

test. Hulbert lost a large part of his interest, becoming much embittered with Quincy Shaw and the Boston directors. In 1884, however, a settlement was made with him, whereby he received \$300,000 in Calumet & Hecla stock, which was placed in trust, so that he lived comfortably for the rest of his life.

The Hecla paid its first dividend, of \$5 per share, in December 1869; and the Calumet in August 1870. The two companies were consolidated in May 1871, absorbing the Portland and Scott companies at the same time. The Calumet & Hecla was then organized with a capital of \$1,000,000 in 40,000 shares. At that date (1871) the dividends of the united mines had already amounted to \$2,800,000. In 1874 the output was 230,000 tons yielding 4.28% copper at a cost of \$7.40 per ton of ore. In 1879 the capital stock was increased to \$2,500,000 in 100,000 shares of \$25 each, this being the limit allowed by the laws of Michigan. By 1881 eleven shafts had been sunk and an estate of 1720 acres had been consolidated. In 1883 the average width of stope was reported as 8 feet and the average yield 4.5% copper. The mine was then 3000 ft. deep on the dip, equivalent to 1950 feet vertical. In 1905 the charter of the company was amended so as to allow it to acquire control of other mines and organize subsidiary companies, whereby it now controls the Ahmeek, Allouez, Centennial, Osecola, Superior, and a number of other properties in the copper region of Michigan. These are now helping to redress the exhaustion of the original mine. The deepest shaft, the Red Jacket, is bottomed at a vertical depth of 4920 feet, cutting the lode at 3287 feet. As our readers know, the lode is cut on its dip in the adjoining Tamarack mine, in which the 'C. & H.' has a large interest. Up to date the company has paid \$130,750,000 in dividends, or \$1339 per share. The total production of copper is estimated at 1,342,500 tons. During the year 1915 the output of the Calumet & Hecla mine was 3,188,583 tons of ore yielding 71,030,518 pounds of copper, or 1.114%, at a cost of 9.33 cents per pound, as against an average price of 18.11 cents. The mine cost per ton of ore was \$1.71. During last year the company paid \$5,000,000 in dividends, drawing \$866,766 from its subsidiary companies. While the management was at one time both unprogressive and self-satisfied, it changed for the better about 15 years ago and is now highly respected, thanks measurably to Mr. James MacNaughton, the general manager, who was born at Calumet and has been in charge for nearly 20 years. Under its Boston control the mine has been worked as a source of copper and a legitimate investment, so that it escaped the stigma of chicanery that has marred the reputation of many other famous mines. To its proprietors, its employees, and the community around this big group of mines, the company has been a fruitful enterprise. Calumet & Hecla may be regarded as the most successful mine on record. We join in congratulating the directors, the management, and the staff, and hope that under its policy of sagacious expansion it may long continue to make a large contribution to the copper supply of the world.



DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Fine Grinding: Stamps and Ball-Mills

The Editor:

Sir—In your issue of May 13, Mr. Hanson's article contains the following statement: "At the mill of the Alaska Gold, at Juneau, a much more radical departure was made from what was considered standard practice in precious-metal ore-reduction. Here rolls and tube-mills, instead of stamps, were installed and this within hearing distance of the roar of the falling stamps at Treadwell. * * * This departure from conventional practice has probably done more toward sounding the death-knell to any future stamp installation on a large scale than any previous attempt to break away from standard method. * * * That this method of reduction is more economical both as to initial and operating costs than stamps alone, or than stamps when working jointly with tube-mills and grinding to a like fineness, can no longer be questioned."

It is well to ponder a moment. The stamps have served us so well that it is hardly fair to scrap them at one sweep. Granted that the initial cost of rolls and tubes is less than stamps, the stamp-mill has not been surpassed in economy to such an extent as to be unworthy of further consideration.

A point that is often overlooked is that the stamp-mill gives a finished product in one operation, whereas with rolls and tubes, etc., you will often hear of a certain machine handling an enormous tonnage at a very low cost, if you look a little further you will find that a lot of other machines are used to complete the job, so that in terms of finished product the cost per ton is something different. To make a comparison it is wise to consider the cost of the finished product.

Fortunately we have here, within the radius of a few miles, one mill, the Alaska Gold, using tubes and rolls; another, the experimental mill of the Alaska Juneau, using stamps as a primary crusher and finishing with Chilean mills; and last, but not least, the old stamps at Treadwell.

The actual cost, in operating, interest, and depreciation, for the mills at Treadwell during the year 1915 are as follows:

Mill	240		300		Ready
	stamps	stamps	Mexican	700-ft.	bullion
Crushing	\$0.038	\$0.038	\$0.040	\$0.037	\$0.022
Tramming	0.014	0.016	0.016	0.015	0.019
Stamping	0.211	0.189	0.192	0.170	0.182
Concentrating	0.066	0.059	0.058	0.052	0.070
Total	\$0.329	\$0.302	\$0.306	\$0.274	\$0.293

These data were kindly furnished by Mr. S. B. Combest, metallurgist for the Alaska Treadwell Company.

The comparative cost, as near as can be obtained, at the Alaska Gold is 33 cents. That of the Alaska Juneau experimental mill, using stamps as a primary crusher, is 32 cents per ton.

The Marcy mill with "one easy step" is looked upon favorably as a solution of the problem. This type of mill is to be installed at the Alaska Juneau and the results will be watched with great interest. The plans for consolidation and centralization at Treadwell include a new mill to replace the scattered units. What will it be?

W. E. CAHILL.

Treadwell, June 19.

Sunday Work at the Mine

The Editor:

Sir—I hope that Mr. F. C. Brown in your June 17 issue has started something, for this subject should provoke an interesting and instructive discussion. I am afraid, however, that the majority of men who turn to Trantwine or Rankin when in doubt will not so readily accept the authority quoted by Mr. Brown when it comes to mining and milling.

You know, it is a generally accepted idea that anything can be proved by the Scriptures. Paul says: "Prove all things. Hold fast that which is good," and I believe this thing is susceptible of actual proof. I have always been an advocate of Sunday closing of the mine, though I have never found a board of directors willing to put it to the test. Like many other things in this life, it depends upon the point from which the view is taken. A great many mines do shut-down on Sunday, but it is usually because the mill can be kept running seven days by six days work underground. There are few who will not admit that a man is a better workman for a weekly day off, except the poor unfortunate who comes back Monday morning chewing a dark-brown taste and feeling for his head at arm's length, and I respectfully submit that the one place in the world where a man of this class is not needed, be he mucker, miner, foreman, or superintendent, is underground, where the safety of all is so inter-dependent.

Whether the same be true of machinery or not, is another question, though many will state as a fact that it is. Certainly the mill that requires 52 days repair-work per annum is either poorly constructed or grossly neglected.

By far the majority of mining camps are isolated and their orebodies limited or uncertain, consequently there is little idea of permanency. Machinery merely to serve the purpose is installed; dwellings are cheap shacks put up without thought to sanitation or convenience, while culture of flower-gardens and trees would be the very last consideration; trails are used until road-building has become an absolute necessity. All this has developed a class of men unsettled in habits and ideas—here today and off tomorrow—packing a roll of blankets or at most a small cheap trunk.

Among the real reasons, as I see them, for running the mine on Sunday are inadequate development, storage capacity, or transportation facilities to meet the demands of the reduction plant. Pumping or ventilation might be necessary and a watchman might be a dead expense.

I believe the mill should be kept running every minute possible for 365½ days per year. Every hang-up, whether in amalgamation, cyanidation, or concentration means a loss not only of uncrushed ore but in the adjustment of pulp and solutions. It is not necessary to speak of blowing-in a smelter-furnace every Monday morning. The regular mill-crew or a part of them could lay off Sunday, their places being taken by substitutes who act as a reserve and are preparing themselves to become mill-men, getting their day on Saturday or Monday. But (and I emphasize the 'but') if we turn a camp-full of 25, 50, or 100 men out on Sunday who have been accustomed to work on that day, we must substitute something else, for it is a true saying that an idle brain is the devil's workshop. It makes no difference to the owner or manager how a man puts in his time; whether he goes to church or fishing, to a base-ball game or lolls about and engages in idle conversation, so long as he does not indulge in vicious practices that unfit him for his work; for, after all, it is not his time that he is selling to his employer, but what he can accomplish during that time. And this is where true management comes in. There are manifold possibilities in the club, the base-ball team, the camp-band and dances, athletic contests, beautifying of cottage grounds, the up-building of the idea of "our camp," but the management must avoid paternalism, for this is the one thing above all else that the American will not tolerate.

It requires tact and patience, but in time, by quiet elimination, a crew of men can be gathered who will gladly respond, and of whom any manager can be justly proud. I know one camp where before the end of the third day the new-comer would not think of coming to the dinner-table in his shirt-sleeves, and everything was quiet and orderly, even though the greater part of the men put their knives in their mouths. Needless to say, there were no flies in that dining-room, nor odors from the kitchen or swill-barrel. The superintendent had a tube built in the wall from his room to the dining-room down which he would occasionally send strains from his phonograph, and Saturday nights the tables and chairs were set back against the wall for a dance. I have not

yet seen a neater tidier camp with a more substantial mill and other buildings away back in difficult country far from the railroad nor known a superintendent who obtained more hard willing work from his men. Very few men were discharged and there were no drones. They eliminated themselves.

It might almost be said that each mine is in a class by itself, and that the rules applying to other camps and more especially to farming and manufacturing districts will not fit.

The underlying and commanding principle is one of time. The owner lives in the city and demands returns on his investment as soon as possible, realizing that all mines eventually, from their very nature, must cease to produce. I am willing, however, to believe that if he is shown that the betterment of the condition of his men will produce better men and better and more work, consequently profit, he will be equally willing to give the manager a chance to prove or disprove any theory. But the manager must believe in it himself and make more than ordinary effort. The mine owner will tell us that all our big men, our successful men, were and are workers, putting in long hours and continuous days. True and well. They are so constituted and have an object and pleasure in their work, an aim for their effort. I was reading an article just a few days ago in which it was stated in effect that only about 10% of us are successful anyway. Of course, that calls for a definition, and I modestly offer that success is the attainment of an individual's ideals, and it is the part of civilization to raise the standard of ideals.

So it resolves itself into a problem of sociology and not of religion, with perforce the dollar sign acting as a governor.

HENRY S. REED, JR.

Shawmut, Cal., June 22.

ARIZONA has a number of copper-mining companies, rivaling Michigan in that respect, and contrasting with the copper-mining industry in Montana, Utah, Nevada, Alaska, and New Mexico, where one or two large companies account for the bulk of the output. Of large mines Arizona has a full share. It is scarcely necessary to mention the Copper Queen and Calumet & Arizona at Bisbee, the Inspiration and Miami at Miami, the Ray Consolidated at Ray, the Old Dominion at Globe, the United Verde at Jerome, the Arizona Copper at Clifton, and the New Cornelia at Ajo. Among companies of more moderate size are the Shattuck-Arizona at Bisbee, the Consolidated Arizona at Humboldt, the Arizona Commercial and Iron Cap at Globe, the Shannon at Metcalf, the Detroit Copper at Morenci, the Ray-Hercules at Ray, the Magna at Superior, the United Verde Extension at Jerome, and several others less well known. The Shattuck-Arizona Copper Co., which produced 11,154,211 lb. of copper in 1915, makes occasional shipments of lead ore. The Magna Copper Co. produced 6,046,459 lb. of copper last year from 59,219 tons of ore, which is well over 100 lb. per ton.

Surficial Indications of Copper—IV

By Frank H. Probert

IN THIS article I shall digress somewhat from the sequence of thought followed in the three preceding contributions to the study of the forces, physical and chemical, that determine the nature of the outcrop. In the discussion of the chemistry of the oxidized zone, I explained briefly the nature of the surface solutions and the formation of the several important oxidized salts in the laboratory of the earth's crust. In the paragraphs that follow I shall first describe the duplication of Nature's work in the belt of leaching, as imitated by man in the treatment of the pyritic ores of Rio Tinto, and then compare the attractive gossan of the Huécula deposits with the insignificant outcrops of the Butte vein-system, interpolating such notes as are pertinent to the subject, gathered from other districts. I have visited and studied both the Spanish and Montana mining districts, but acknowledge, and have abstracted from, the lucid descriptions of A. M. Finlayson¹, and Reno Sales², respectively.

For many years pyritic ores from the open-cuts at Rio Tinto were piled into heaps, fired, roasted sweet, and then washed with water. The copper sulphate liquor was passed through precipitating-tanks and sponge-copper obtained. This process was costly, the sulphur was burned off, all vegetation killed for miles around, and endless trouble ensued. The 'natural cementation' process was developed from the chance observation of a colored liquor running from the base of an unroasted heap of ore, after a heavy summer rain. This contained copper. It was seen that roasting was unnecessary and that the time element could replace the effect of heat. This discovery led to systematic experimentation, the present method of treatment being devised about 25 years ago. I shall not dilate on the relative advantages of this method and the old wasteful practice of heap-roasting.

The ore from the pits is crushed in rock-breakers to 2½-inch ring, sized, and transported to the heaps. The ore, as laid down, contains about 2% copper, 52% sulphur, and 46% iron. The fine and coarse are mixed in varying proportions, according to the depth of the heap. At Rio Tinto, the ratio is 3 of fine to 7 of rough. When the heaps are too deep, the air will not circulate freely throughout the mass and the lower portions cannot be controlled. If not deep enough, aeration is too rapid, and the heap may take fire. Experience has shown that the most suitable depth is about 10 metres. The surface is covered with fine that serves as a filter for the wash-water. A simple irrigating system is arranged, the main canals feeding into furrows or shallow rectangular reser-

voirs so that water can be distributed to any part of the heap, as required.

The oxidation of pyrite is an exothermic reaction; heat is liberated and the mass will burn unless precautionary measures are taken to prevent it. Underground mine-fires are not at all uncommon in pyritic masses, owing to the heat generated in oxidation. At Jerome, Arizona, a special force of men is maintained to keep the fire-zones under control. When last at the United Verde, I noticed a crystalline sublimate on the timbers and walls of the openings near the fire-areas, which, on analysis, proved to be arsenic trioxide, 85% pure. This came from the arsenopyrite associated with the cupriferous sulphides. At the Coronado mine of the Arizona Copper Co., at Metcalf, when shrinkage stoping was first tried, a serious fire broke out and much valuable ore was lost. The trouble was in the size of the stopes. Peter B. Scotland, the mine manager, informs me that by working smaller stopes and drawing off the broken ore as quickly as possible, the danger of fire has been minimized.

Because of this tendency to burn, the temperature of the heaps at Rio Tinto has to be carefully regulated. It is found that the best results are obtained at about 120° F.

The washing of the heaps serves to keep the temperature down, forming ferrous sulphate and free acid, which react to form ferric sulphate. This attacks the copper sulphides, the resulting copper sulphate being leached out and carried away by the effluent liquor.

The amount of water used, per ton of ore treated, varies. At Tharsis it takes four cubic metres, half of which is required during the first year, one cubic metre for the second year, and one cubic metre to finish the leach. This quantity of water seems abnormal, but the spent liquor from the precipitating-plant is returned to the heaps to continue the work, so that the cycle is complete and the loss small. It takes about four years to extract all the copper. At both Rio Tinto and Tharsis, 50% of the copper in the ore as laid down is extracted in the first 12 months; 25% during the second year, and the remainder in the next two years, but at the end of the time, the pyrite is to all intents and purposes unaltered. Examined macroscopically, if the heaps have been properly regulated, it is difficult to distinguish between raw and leached ore, but the leached material has a more or less rusty appearance, due to films of iron oxide that have formed on inter-crystalline faces, and the mass is not quite so homogeneous. I have repeatedly observed that the periphery of pyritic orebodies, in the early stages of oxidation, presents this same appearance. On the 1000-ft. level of the Cole shaft of the Calumet & Arizona mine, at Bisbee, a cross-cut was run to the

¹Economic Geology, Vol. 5, pp. 403-434.

²Trans. A. I. M. E., Vol. 46, pp. 1555-1560.

Briggs shaft. It was in hard blue Devonian limestone, which, as an orebody was approached, became more blocky, the cleavages showed slight limonitic staining, and soon a mass of friable rusty pyrite was encountered, which ran like sand. When it was cleared, a partly oxidized orebody of cupriferous pyrite was opened up. The same condition was noted in the glory-hole and upper levels at the United Verde, but here there was an appreciable increase in the gold content. I have seen it at Butte, at Metcalf, and in surface exposure at a number of other mines. It is due to the leaching of the minute grains of chalcopyrite filling the inter-crystalline spaces of the pyrite. I consider it a favorable indicator either in surface exposure or underground development. It denotes the presence of cupriferous pyritic masses.

On looking over the leached heaps, I found that any lumps of chalcopyrite were but superficially altered. Fineness of division promotes chemical change. So, too, in outcrops or the upper workings of mines exploiting copper deposits, chalcopyrite is relatively resistant to the attack of oxygenated waters, whereas, when the two sulphides are associated, as cupriferous pyrite, the copper readily oxidizes. Possibly this is a catalytic reaction.

An analysis of the liquor leaving the heaps at Tharsis showed it to contain, at the time of my visit in 1900:

Copper	2103 grams per cubic metre.
Ferrous oxide.....	12252 grams per cubic metre.
Ferrie oxide.....	1710 grams per cubic metre.
Sulphuric acid.....	1297 grams per cubic metre.

At the Cerda plant of the Rio Tinto, the liquor contained 1445 grams of copper and 1570 grams of ferrie iron per cubic metre. As pig-iron is used to precipitate the copper, there would be an inordinate consumption of this material if the ferrie iron was not reduced before the liquors reached the precipitation-tanks. To effect this reduction, the liquors are made to filter through a small heap of fine material from richer ore. The ferrie salt is reduced to the ferrous stage with an increase of copper content, so that the liquor leaving the reducing beds contained 1583 grams copper and only 120 grams ferrie iron. This means a reduction of 1450 gm. of the persalt to the proto-salt—about 90%. I suggested, in my report to Phelps, Dodge & Co., for whom the investigation was made, the possibility of using a ferrie liquor obtained from the slow oxidation of a pyritic heap, for extracting copper from the low-grade oxide ores, of which they have such a large tonnage too low-grade to be worked profitably, in their mines at Morenci, Arizona. I subsequently conducted a series of tests along these lines, but had to record what Huxley termed a scientific tragedy, the killing of a beautiful theory by an ugly fact, for, try as I would, I could not get a sufficiently strong ferrie liquor by natural oxidation of the Morenci pyrite. Ferrie sulphide is slowly reduced by copper carbonates and oxides, and the copper dissolved, although sulphuric acid is a much more ready solvent. The Arizona Copper Co. leaches the tailing from the rough oxide-ore concentrator by sulphuric acid, at a substantial profit, and the same

solvent will be used at Ajo, Arizona, and at Chuquibambilla, in Chile.

It is probable that the free acid formed by the attack of oxygenated meteoric waters on sulphide minerals is the most potent factor in the early change of copper outcrops, and that as the supply of free air is diminished, the ferrie solutions become more and more active.

The rich blue liquor leaving the reducing beds at Rio Tinto is in striking contrast with the deep-green entering ferrie waters. The copper is precipitated in an elaborate series of tanks, aggregating about three kilometres in length, the inclination of which increases as the copper is precipitated. For the first 40% of the copper, it is 1 in 200; for the next 30%, 1 in 150; then 1 in 100, and for the last 10% of the copper, 1 in 50. For the first 80% of the copper, the tanks are 90 cm. deep, and for the rest of the run only 30 cm. If there is much ferrie iron or free acid in the liquors, they are by-passed to tanks of greater slope. This prevents the throwing down of arsenic, the tendency of which increases as the quantity of copper is lessened and free acid rises. The upper tanks precipitate the bulk of the copper, 60% being taken out in the first 700 metres. The spent liquors, leaving the tanks to be pumped back to the ore-heaps, show a complete reduction of the ferrie iron, and a neutralization of 600 gm. of free acid per cubic metre. Over 70% of the copper precipitate assays better than 94% copper.

The consumption of pig-iron at Tharsis is 1.25 lb. per unit of copper obtained.

I have described this natural cementation process not only because it presents many novel features, but because the reactions are the same as those that occur in the natural oxidation of ore deposits. Man substitutes heat for time, but Nature cannot be hurried. It may be questioned by my readers why the rich copper sulphate liquor does not precipitate or form enriched sulphide, such as chalcocite, when it passes through the so-called reducing beds. This apparent contradiction to the theory of chalcocitization is readily explained if we desist from thinking of laboratory conditions when discussing geological processes. At Rio Tinto, the success of the method depends on the aeration of the heaps and the maintenance of special conditions of temperature, porosity, and flooding with solutions under control. In the confines of the earth's crust, free air cannot enter to any extent, and totally different conditions exist.

The relative solubility and order of attack of the sulphide minerals has already been mentioned.³ The effect of the association of the natural sulphides on the rate of oxidation has also been explained.⁴ After four years oxidation and washing the iron pyrite of the Rio Tinto heaps is practically unaltered, but, geologically, four years is a negligible interval of time. The hematitic croppings of veins or masses are the result of the long-continued attack of chemical and physical forces.

The pyritic copper deposits of Huelva, Spain, occur as a series of lenticular masses, showing marked variation in

³M. & S. P., Vol. 112, p. 894.

⁴Op. cit., p. 895.

size, in a metallographic province extending for many miles from the province of Seville, westward into Portugal. Roughly speaking, these irregular masses of cupriferous pyrite are from 1000 to 2000 ft. long, 100 to 300 ft. wide, and of a depth consistent with the other two

orebody, others may apex with the little end up. An insignificant outcrop may represent either the top or bottom of a lens of ore. It is doubtful if many of the Huerva deposits would be known today had it not been for long-continued erosion. The orebodies are of deep-



INCIPIENT MINERALIZATION OF BUTTE GRANITE, 600-FT. LEVEL,
BERTHA MINE, CORBIN, MONTANA.

dimensions of a lenticular mass. Denudation or erosion has been the all-important factor in determining the present vertical extent of the orebodies now being worked, or such as are indicated at the surface by gossan outcrops. One lens may feather out a short distance below its outcrop, showing only the root of an eroded

orebody, others may apex with the little end up. An insignificant outcrop may represent either the top or bottom of a lens of ore. It is doubtful if many of the Huerva deposits would be known today had it not been for long-continued erosion. The orebodies are of deep-seated origin, formed during Permian-Carboniferous time. Of the 33 known deposits, 4 are enclosed in porphyry, 2 at the contact between slate and diabase, 11 at the contact of slate and porphyry, while 16 are wholly within the metamorphosed sedimentary rocks. They cannot be related genetically to any one group of igneous rocks. As I have already pointed out, an orebody may be, and often is, the result of cumulative processes of mineralization, the metallic emanations of one magma serving as a nucleus or locus of deposition for the heavy vapors from later intrusives. The wall-rocks are impregnated with pyrite, enriched in places to form workable deposits. The whole section of country has been repeatedly fractured and sheared,

but the pyritic masses themselves do not show extensive alteration on account of their massive and resistant nature. Imperfect jointing has, however, been developed.

As a result of careful microscopic work, Mr. Finlayson finds that the copper present in the ore is not chemically



OUTCROP OF QUARTZ-PYRITE VEIN IN ALTERED GRANITE, BUTTE, MONTANA. (Copied from Professional Paper No. 74, U. S. G. S.)

combined with the pyrite, and that secondary chalcopyrite followed by chalcocite in the narrow orebodies, and chalcocite in the lean deeper ores, is the evidence of enriching processes. He also states that the preliminary changes, due to enrichment, extend far down into what is usually regarded as primary ore. The unenriched ore is essentially a mechanical admixture of chalcopyrite and iron pyrite.

The oxidized zone or gossan consists of massive hematite containing over 50% iron. The average depth of it is about 100 ft. The depth of oxidation has been determined in all cases by the topographic level of groundwater. The width of the outcrop and the boldness of its exposure depend upon the plane in the vertical scale to which erosion has advanced. The ore is mined by open-pit methods. To anybody standing at the edge of one of these large pits, the colors of the several zones appear most vivid; the deep red of the capping contrasting strikingly with the pale bluish-green of the sulphides. Between the leached overburden and the pyritic ore, there is a ribbon, several inches wide, of bright ochreous-yellow material containing the concentrated precious metals of the oxidized zone.

This ribbon, carrying the concentrated precious metals, was formed by the precipitation of the dissolved gold and silver in oxygenated ferric sulphate solutions, as soon as the strongly reducing influence of the pyritic zone was reached. It is not a mechanical concentration, for the overburden of massive hematite, from 50 to 150 ft. deep, dependent on erosion, is very compact. This yellow layer will assay \$30 to \$40 per ton.

The upper zone of the enriched sulphides shows a slight impoverishment, and below this narrow belt the ore is richer in chalcocite, running as high as 6 and 7% copper. This gradually fades into the cupriferrous mass below. There is an abrupt change between the oxidized and enriched ore, but no sharp line of demarkation between the enriched and primary pyritic ore. The zone of transition is variable in extent, but the average depth of enrichment is from 150 to 200 ft. below the gossan or 250 to 350 ft. below the surface. To this depth the ore has averaged about 3%. The relation between the depth of enrichment and the depth of gossan is particularly well emphasized in this district. There is no appreciable quantity of copper salts in the oxidized capping. The chemical processes of cementation have proceeded faster than the physical forces of denudation. The rainfall, about 25 inches per annum, has been sufficient to ensure deep alteration, but insufficient to cause rapid erosion in a country of gentle slopes and smooth surfaces.

Mr. Finlayson summarizes his views concerning these deposits as follows:

1. The pyritic orebodies of the Huelva district constitute a metallo-genetic province accompanying a petrographic province; and the concentration of the ores has been due, in the first place, to a process of magmatic segregation of sulphides accompanying the differentiation of the igneous rocks, and dependent, with this latter, on the Hercynian tectonic movements.

2. The ores have been deposited from solutions that, after the cessation of the igneous outbursts, rose along great thrust-planes or shear-zones; and the deposit was effected by replacement of the sheared and crushed rock by the ores.

3. Since the formation of the lodes, great denudation, with accompanying sulphide enrichment (by descending waters) has taken place, and to this enrichment the economic importance of the deposits as a source of copper, and the leading position of this locality among the great copper districts, is very largely, if not entirely, due.

In Finlayson's comprehensive description of the pyritic deposits of Huelva, no mention is made of the influence on the alteration of the pyritic masses by a migratory water-level, nor am I able to find in the review of the literature of these deposits any comment on the relationship of structure to the oxidized zone. The absence of faults, shearing, or prominent joint-planes, or, in other words, the general compactness of the gossan, anticipates a slow and complete oxidation of the mass to a definite horizon and accounts for the abrupt change from the leached material to the enriched ore. There is unquestionable evidence of great tectonic movements later than the ore deposits, but these only find expression in the surrounding rock or at the lode-walls. I have already pointed out that structural details have a great influence on the depth of oxidation and on the enrichment of ore below. The slow and continued solution of the copper contained in the upper part of the Rio Tinto deposits probably accounts for the complete extraction of the copper, and the general distribution of the enriched ore along horizontal planes in gradually decreasing amount as depth is attained. This seems to be a general condition in all such pyritic masses that I have examined. At the United Verde mine, in Arizona, large pyritic masses have been explored, but none find surface expression. I noted there that, where the erratic bodies traversed by highly altered dioritic rock, along lines of structural weakness, the pyrite is locally enriched with secondary chalcopyrite. At the Copper Chief mine, a few miles from the United Verde, the outcrop of one of these pyritic orebodies shows as a loosely coherent, sandy, limonitic mass with little or no oxidized copper salts. Here, too, the zone of oxidation is limited by an approximately horizontal plane. Referring to the massive pyritic deposits of Ducktown, in Tennessee, W. H. Emmons says, "The secondary zone is less extensive vertically than most chalcocite zones elsewhere. The lodes are comparatively impervious to downward circulation, and it is believed that the reactions were brought nearly to completion before the descending oxidized solutions had moved downward great distances."

At Fierro, in New Mexico, the sudden change between oxidized capping, which is shipped by the Colorado Fuel & Iron Co. as an iron ore, and the lean, compact, underlying pyrite, is very noticeable. J. A. Reid has called attention to the effect of lateral pressure on the down-

ward passage of meteoric waters, and in this way explains the absence of a zone of enrichment in the Cop-peropolis deposits.⁶

J. W. Finch thus describes the La Reforma mine, in Guerrero, Mexico:⁷ "The topography is very rough, which pre-supposes rapid run-off. The orebodies consist of massive pyrite, chalcopyrite, and associated sulphides. An imperfect joint-structure has developed in the mass, but no openings that would admit of widespread percolation of meteoric waters. Such fracturing as there is, is apparently recent. The capping is of the usual gossan type, containing no copper, but gold, silver, and lead are concentrated above the pyrite zone. All the value of the oxidized zone is residual. The pyrite mass was saturated with water held there by capillarity between crystal faces, thus preventing the downward seepage of surface waters and consequent enrichment. Such copper as was leached from the gossan capping has been diverted laterally and escaped with the run-off. The line between the zones of oxidation and enrichment is as sharp as that between two surfaces."

While discussing pyritic masses, of which Rio Tinto is a type, it may interest my readers to know that these Spanish mines have been worked intermittently for over 2000 years. They were successfully operated by the Romans and by the Phœnicians before them. Siculus, writing of the Spanish mines in the first century B. C., says, "Sometimes at great depths they met great rivers underground, but by art gave check to the violence of the streams." "They admirably pumped out the water with those instruments called Egyptian pumps, invented by Archimedes. By these, with constant pumping on turns, they threw up the water to the mouth of the pit and thus drained the mine; for this engine is so ingeniously contrived that a vast quantity of water is strangely, and with little labor, cast out." "The re-opening of the mines at Rio Tinto in the middle of the eighteenth century disclosed old Roman stopes in which were found several water-wheels. These were about 15 ft. in diameter, lifting the water through a reverse arrangement to an overshot water-wheel. A wooden Archimedian screw was also found in the neighborhood."⁸

Enormous slag dumps, undoubtedly of Roman time, are still to be seen at Rio Tinto. They are bi-silicate slags, unaltered by weathering during this long interval of time, and on analysis I found them to contain less than 0.2% copper. Such metallurgical work we, with all our modern plant, can scarcely duplicate today. Several relics of the old Roman mining methods survive. Slave labor was used, and there is every reason to believe that 'high-grading' was practised just as much in those days as it is now. The miners would steal a handful of the yellow material found between the overburden and the ore and, having accumulated sufficient for a charge, would melt it down in small scorifying furnaces made of adobe. The yield was in the form of plaques running

98% silver. Several of these were found while I was in Spain, cached away in some old workings.

From Huelva to Butte is a far cry. The climatic conditions are totally dissimilar, the ore deposits are of two distinct types, the one is worked by open-cut mining and steam-shovels at comparatively shallow depths, the other



RIO TINTO. A BENCH IN THE MAKING AT THE EAST END OF THE SOUTH-COBE OPEN-CUT.

by shafts to depths of 3000 odd feet; in one the ore occurs as massive lenses, at the other in definite veins; at Rio Tinto faults have played a minor role in the enrichment and have not interfered with the ore lenses, at Butte all the veins are faulted and a most complicated structure results; the Rio Tinto deposits have most attractive surface showings, while the Butte outcrops are inconspicuous to the degree almost of non-existence.

⁶*Economic Geology*, Vol. 2, pp. 380-417.

⁷*M. & S. P.*, Vol. 101, p. 498.

⁸Hoover. 'De Re Metallica,' p. 149.

The Butte district has been studied exhaustively. It has, probably, received more attention from competent geologists than any other copper district in the world. All agree as to the rock sequence and the complex structure, but there is no uniformity of ideas as to the age of the several ores found there. Under the direction of Reno Sales and his geological department, practically all of the exploratory work of the Anaconda Copper Co. is planned. The value of the services of the economic or mining geologist in directing mining work has been recognized and demonstrated in this field. On behalf of the U. S. Geological Survey, W. H. Weed investigated the district and presented his findings as Professional Paper No. 74. His unravelling of the fault-complex and deductions as to ore genesis served as a basis for the more complete investigation of Sales, the results of which were published in the Transactions of the A. I. M. E., Vol. 46, pp. 1523-1626. The later work of J. C. Ray called attention to the sequence of sulphides in the Butte ores.⁹

The Butte district, of which Anaconda hill is the centre, is made up almost entirely of a highly altered quartz-monzonite or 'granite,' as it is locally called, which is a part of the great Boulder batholith. The productive area is about $1\frac{1}{2}$ miles long and 1 mile wide, although many mines have been opened up in the same granite mass within a radius of 30 miles of Butte. Differential cooling of the granitic magma resulted in the intrusion of acid dikes of aplite, the economic significance of which is not apparent. Later acid intrusions of rhyolite have probably a genetic connection with the copper ores.

The copper output of Butte comes from vein mines. All the ore is confined to definite fractures; and while the granitic wall-rocks are pyritized, they are non-commercial. Several of the shafts have reached a depth of 3000 ft. and as yet there is no indication whatever of impoverishment.

Fissuring of the granite is a common feature throughout the batholith. In addition to the fissuring, profound faults of several periods of regional disturbance, both before and after vein formation or mineral deposition, have brought about a condition of intricate complexity, which has resulted in so much litigation. The fissures may be divided into six distinct systems, of which the Anaconda or east-west system is the oldest, as well as the most solidly and continuously mineralized. The oldest fault fissures in which ore is found constitute the Blue system. Extensive rock alteration has taken place, particularly in Anaconda hill. It is closely related to the important vein-systems. The alteration has affected both the country rock and the veins and faults. It is due to the effect of the early mineralizing solutions, to the influence of descending waters, and to natural oxidation. These processes overlap. The greatest change is noticed in the oldest, or Anaconda, vein-system. The faulting and crushing of the Butte granite has been on a profound scale, and both chemical and dynamic agencies have combined to bring about present conditions. The

granite is pyritized and nearly all the ferro-magnesian minerals are obliterated; the feldspars develop sericite and secondary silica. In the upper levels kaolinization is advanced owing to the action of sulphate waters upon the sericitized granite.

The effects of hydro-metamorphism are more noticeable where vein-forming influences have been most active, that is, in the zone associated with the Anaconda vein-system. The most marked effects are kaolinization and chalcocitization, accompanied by greater porosity. The average depth of the oxidized zone is 300 ft. in the highly altered area. While chalcocitization is always accompanied by kaolinization, the reverse does not hold good, and it is thought that sulphate waters have been active at depth, long after the last trace of their contained copper had been precipitated as chalcocite. A distinction between 'sooty' chalcocite of secondary origin and 'primary' chalcocite, which occurs in quantity, is important. The zone of secondary chalcocite varies from 50 to 200 ft. in the fault-veins to a maximum of 1200 ft. in the older veins of the Anaconda system.

It is probable that surface waters have caused changes in the rock-mass beyond the depth reached by mine-workings. On account of the structure, the ground-water level is very variable. Present ground-water, even where found at great depth, is of meteoric origin and contains appreciable quantities of free acid and the iron sulphates. Secondary enrichment in the Butte district is dependent largely on the topography and the mineralogic and physical characteristics of the vein in which the sulphides occur.

Ice planation, rock disintegration, erosion, and the Continental fault have determined the present surface contours and caused a mantle of wash to mask many of the intersections of the veins with the surface. Aside from this, the outcrops are indistinct and are seldom recognizable in the absence of shafts or pits. Butte has the least surface evidence of mineralization of any district I have studied. The highly colored oxidation products of copper minerals are conspicuous by their absence, and with the exception of local developments, no oxide ores are mined at Butte. Almost without exception, the copper veins are practically barren of copper at the outcrop and in the zone of oxidation. The outcrop of a typical vein of the Anaconda series is marked by altered granite, quartz, and iron oxides. The quartz sometimes exhibits honeycomb structure; infrequently there is a little clay that may be slightly copper stained.

The fault-veins are similar, except that there is usually one or more well-defined fault clay-walls. "Taking a broad view of the entire copper producing area, it may be said with emphasis that there is but little if any evidence of a positive character to be found in the outcrops or the oxidized zones of the Butte veins to indicate the existence of copper in commercial quantities at greater depths."¹⁰

The manganese-silver veins, forming a crescentic arc to the north of the copper veins, outcrop boldly and may

⁹ *Economic Geology*, 1914, p. 463.

¹⁰ Reno Sales, *Trans. A. I. M. E.*, Vol. 46, p. 1556.

be traced for hundreds or even thousands of feet, on the surface. The zinc veins, closely associated with the manganese-silver series, show as quartz, or rhodochrosite ribs at the surface, the zinc-blende being found 200 to 300 ft. below.

The depth of the zone of oxidation at Butte is exceedingly variable. It depends upon the nature of the veins and the wall-rock, rather than on the topography. The quartz-pyrite veins of the Anaconda system are more deeply oxidized than the fault-veins. The clayey material hinders percolation. Again, the fault-veins are not as heavily pyritized, hence the solutions are not as strong. The oxidized zone shows but little change physically or chemically, from the surface to the sulphide ore, but the change between them is very abrupt. In the Anaconda series enriched ore immediately underlies the oxidized belt, whereas, in the fault-vein system, large areas of barren, unoxidized vein-matter often separate ore-shoots.

In areas of great rock alteration, the rocks and veins are saturated with water. The many periods of fault-

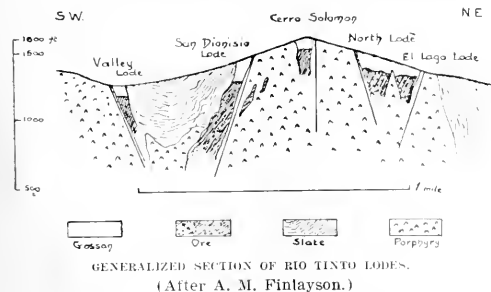
The granite itself is intricately jointed and the climatic conditions are such that boulder-structure is quickly developed, rock disintegration proceeds rapidly, and erosion is advanced. The granite is pyritized along the joints and in the ferro-magnesian mineral constituents. The oxidation of this pyrite would of itself be sufficient to upset the homogeneity of the mass, thus assisting erosion. By oxidizing processes, the feldspars and mica become sericitized. The sulphate waters convert part of the sericite to kaolin and quartz. The present topography is vastly different to that of the mineralizing period, and it is probable that the typical irony outcrops of copper veins have long since been removed by erosion. I have said that other than a rusty staining of the quartz, even limonite is but sparingly developed in the present surface exposure of the veins; this suggests the absence of iron in the ore represented by this remnant. Again, in the oxidized zone, cuprite and some native copper are the most plentiful of the oxidized minerals. These chemical facts, coupled with the physical condition of the district, point to the oxidation of secondarily enriched ores. I consider it highly probable that many of the Butte veins are in the second cycle of oxidizing processes.

Weed says,¹¹ "The quartz-pyrite veins are often distinct, though not conspicuous, but the glance-enargite veins in altered granite can rarely be determined in outcrop; where upraises have been driven to find their apex, it is found to consist merely of kaolinized granite cemented by stringers of quartz. Indeed, one may infer from the absence of limonite that the barren quartz found between the surface and the big orebodies is the result of oxidation of chalcocite and pyrite only.

"The descending waters became charged with ferrous, cupric, and zinc sulphates and have an acidic reaction. All three of these salts are easily soluble in water and all three are carried by the moisture of the air circulating in the mine workings. Such air deposits its moisture by chilling, and as a result many of the old mine workings are coated by efflorescent deposits of zinc, iron, and copper sulphates."

THE METRIC SYSTEM, as applying to American standards of weights and measures, was discussed by Frank Richards in a recent number of the *New York Evening Post*. He argued against its adoption in this country. Regarding the tenet of the advocates of metric weights and measures, who assert that it would be a convenience to American manufacturers in securing trade with the metric countries, such as South America, he stated that the rule works both ways, and that German and French manufacturers are equally handicapped in making goods for our markets or England. Again the metric system was said to be not so scientific as it was claimed to be, because it failed in the facility of continued sub-division by two and three. The advocates of the metric system were stated to be largely college professors, and not the business people who would be affected by a change.

¹¹Professional Paper No. 74, U. S. G. S., p. 39.



ing have, however, brought about local irregularities, and clay fault-dams will cause dry sections, alternating with more open wet zones.

The continued crustal adjustments of the Boulder batholith, particularly that part that was first weakened by vein-forming influences, has contributed to the migration of the metals and so been a vital factor in the economic concentration of the lean primary material.

The mineralogical relations in the Butte veins do not suggest distinct and separate periods of mineralization, but rather one continuous process with varying degrees of intensity.

Reviewing the evidence presented at Butte, the absence of outcrops can be readily explained, and there is nothing in conflict with the ideas I have already expressed concerning the surficial indications of copper. All the ore occurs in one phase or another of a differentiated monzonitic magma. It is confined to definite fractures that have been re-opened subsequently to the primary mineralization or dislocated by later earth-movements. This complex structure has either facilitated or retarded enrichment, dependent on increased facility for deep penetration of meteoric waters by openness of fissures or the damming back of such solutions by the development of fault-clay.

Conditions in Mexico

By Our Own Correspondent

In my letters, appearing on January 29 and June 10, I discussed something of Carranza's extraordinary paper-money system, by which he expected to "save the nation from a public debt and distribute the cost of the revolution equitably among all classes." It is not definitely known, outside the inner governing ring, if the systematic counterfeiting which has been a regular practice of the Carranza Hacienda (treasury) department has inured to the benefit of officials or of the Government itself. A favorite device has been to change the original die, by erasing a line or two, and then to declare false all the previously printed notes from the altered die. Recently the only way to be sure of the genuineness of any Carranza note was to have it officially re-sealed, which not only involved a wearisome delay but the risk of having it destroyed as counterfeit. The unmoral state of Mexican society is well illustrated by the fact that many respectable Carranza partisans defend this official swindling on the plea that "it helps to amortize the public debt."

After the discovery last summer of the wholesale counterfeiting of the ₧50 and ₧100 notes—which culminated in the execution of General Gringás—the Minister of Hacienda, Cabrera, suddenly departed for Europe, probably to escape awkward questioning, but ostensibly to secure a gold loan to back up his new issue of ₧500,000,000 'unfalsifiable' notes, which he had just ordered printed in the United States. Failing in Europe, he started for New York, where he hoped to work on the financiers the same game of diplomatic flattery that Carranza had found so successful among Washington statesmen. But financiers have to pay their own way, and thus, unlike statesmen, cannot afford to cherish any Quixotic illusions as to facts. So Cabrera, in spite of a skillful and arduous social campaign, found himself no nearer his goal of coin than at first, and was finally told that to persist would be useless, as his Government was deemed both incompetent and dishonest. On his return to Mexico in March, Cabrera carefully concealed from the populace the failure of his loan proposals, and soon announced that his plans for the issue of unfalsifiable notes had been perfected and would be put in operation on May 1. During the last week of April, he constructed a new *Comisión de Cambios* of seven members, as he deemed it prudent to have a screen of marionettes to protect himself from the popular odium that the publication of his contemplated financial decrees would be sure to arouse.

During the spring, the press had hinted that the new or unfalsifiable notes would be exchanged for the old notes at par; but the first decree in April announced a ratio of 2:1; while the final decree, by which the issue was

begun on May first, fixed a redemption value of 10 cents (U. S.) per peso for the new notes and $2\frac{1}{2}$ cents for the old notes, or a ratio of 4:1. This promise of redemption of new notes in coin kept their value up for some days, but when it was discovered to be largely a bluff and was being hindered as much as possible at the offices of the *Comisión de Cambios* in order to prevent the escape of real money, their quotation began to drop and was down to 7 cents during the last week of May.

As the decree of May 1 had declared that the old notes should continue as full legal tender until July 1, and thereafter should continue for six months to be receivable for all taxes payable in paper, their holders slept tranquilly on the night of May 31, little dreaming of what would befall them on the morrow. Between June 1 and 3 there was posted all over Mexico a decree that history will doubtless deem the most insane of all the extraordinary efforts of the Carranza régime. The gist of its 14 articles was an abolition of the legal-tender quality of all ₧20, ₧50, and ₧100 notes within three days, after which time such notes would only be receivable as money for a small number of public dues. But if deposited in the Treasury before July 1, they would be paid for on October 1 with gold certificates, which, within five years thereafter, would be redeemed in coin at the rate of 5c. per peso.

But an even worse fate than the nullification of their existing stock of big notes was in store for the merchants, because they were obliged to continue receiving the big notes during the three days following the publication of the decree. A few fortunate ones escaped lightly by closing their stores most of the day and greatly increasing their prices, but many, whose stock happened to be attractive to Carranzista officers, like shoe or hat stores, found themselves beset on all sides and had Hobson's choice of either selling out for worthless notes while at liberty, or of going to jail and having their stock 'intervened.'

But the financial tragedy was not yet over. On June 10 there appeared a new decree declaring that the old notes, which had been declared worth $2\frac{1}{2}$ c. on May 1, were now worth only 1c., and this in future would be valued at only one-tenth as much as the new notes instead of one-fourth. Henceforth, the only remaining legal-tender old notes, those of ₧1, ₧2, ₧5, and ₧10, would have only 40% of their previous value, so that the masses, who had already lost millions by the decree of June 1, found themselves left with practically no money to spend at all.

At first glance it would seem that only a madman could have issued these absurd decrees, which not only repudiated others issued barely a month previously, but

aroused universal indignation even in the Army itself; yet another explanation is plausible: On June 5 the large notes fell to half their former value, so that any paymaster who happened to have a balance of ₧100,000 in small notes could exchange ₧50,000 of it for ₧100,000 of big notes and have a difference of ₧50,000 free and clear for himself, as the accounting rules required his balance to be in legal money, but did not specify its denomination. On June 9 there issued forth, bright and early, from the offices of Nicolas Zembrano, Treasurer of Mexico, scores of clerks carrying satchels full of ₧1 and ₧2 old notes. These eager youths circulated rapidly in the business centre of Mexico City, and offered to everyone ₧5 of these scarce small old notes in exchange for each ₧1 value of new notes, the market rate being only ₧4. Millions were thus quickly sold on June 9 at 5:1;

many employers, "because we have no gold with which to make this purchase." "What do we care," said the Bureau of Labor, "you may do as you please; but remember: if you attempt to close down, a decree is in force providing for the intervention of your plant and stock by the local *prebostal* commission, which will at once put it under the hammer, and from its proceeds pay out a quarter's advance wages to all your patient employees, too long abused by *bourgeois* like you."

Many of the shrewder merchants, discovering some months ago that they surely would fall into bankruptcy if they continued business, and would inevitably be seized by the *prebostal* commission if they tried to suspend operations, have been quietly selling their stock of merchandise. However, this recourse is not open to the owners of mines or factories full of valuable machinery,



AGUASCALIENTES, A SMELTER TOWN IN CENTRAL MEXICO.

these were as readily bought back the next day, after the aforesaid decree had been posted, at half price or at the new ratio of 10:1.

The strikes, in May, of all the workmen of the Carranza railroads and public utilities, for the payment of wages on a gold basis, had been quelled by first declaring martial law, to force the strikers to return to work, and then paying all their wages with new instead of old notes. Naturally, this sudden quadrupling of the pay of public servants made all other workmen dissatisfied, and hordes of them struck for a like change in their wage payments. Many employers offered to compromise by increasing the rate, but continuing to pay in old notes until they ceased to be legal tender on July 1. Yet the strikers would not listen to this and Carranza's Bureau of Labor sustained them in their "righteous objections to such miserly treatment." "Ah," said the beset employers, "we have no new notes, for only the few used for paying the Army and Civil Service since May 1 are now in circulation." "Nonsense," retorted the Bureau of Labor, "the *Comision de Cambios* will sell you all the new notes you may need at the rate of 10c. (U. S.) per peso." "Then we shall have to close our business," answered

and their only recourse is to have such a severe 'accident' to their equipment that operations can be no longer continued.

The author of all this financial legerdemain, Luis Cabrera, was educated for the law, and started his career, like many another attorney of the Diaz régime in Puebla as a go-between for criminals who had money enough to purchase their release from a bench of easily corrupted judges. Later he went to Mexico City, and first entered the limelight about 1908, when he fought a case concerning the water-rights of the Torreón cotton district, against the noted *científico* lawyer, Vera Estañol. Cabrera's remarkable gifts as an orator thereafter kept him well in the public eye till the beginning of the Madero revolution in 1910, when he definitely took the Liberal side by the publication of three open letters against the re-election of Diaz.

When Madero was elected president in November 1912, Cabrera became a member of the Federal House of Deputies, and made a creditable record as an advocate of the restoration to the Indians of their *ejidos* (communal lands) of which they had been robbed by the Diaz ring. After Huerta usurped power in 1913, Cabrera

fled north to join Carranza, and so gained the latter's confidence that he appeared as his spokesman during the military convention at Mexico City in September 1914. About this time F. F. Villareal, the Minister of the Treasury, refused to continue Carranza's policy of unlimited currency inflation, so he was dismissed and Cabrera appointed. Unlike his predecessor, Cabrera had neither a theoretical nor a practical knowledge of finance, but, too conceited to take expert advice and free from moral scruples, he has since persisted in maintaining a national monetary madhouse that has ruined a large part of the middle class, killed thousands of the proletariat by famine and its resultant pestilence, and bids fair, unless foreign relief soon arrives, to exterminate the whole population.

To illustrate what I meant in my June letter by stating that many railroad-cars are the "personal requisite" of some local general, I will take the case of General Medina, long in charge of northern Puebla, in which State are the mine and smelter of the Tezuítlan Copper Co., both shut-down since 1913. The Medina boys, five in number, were born near Matamoros on the Texas border, and, entering the Carranza movement near its inception, had attained high military rank when Carranza came south in July 1914—all except one brother, who remained a civilian in order to manage the business interests of his military family. Controlling absolutely the city of Tezuítlan and its railroad line from Oriental on the Inter-oceanic system, the Medina family now found itself in financial clover, for no freight could move either in or out of the Tezuítlan district without paying them a generous toll.

Other examples of revolutionary patriots are General Luis Gutiérrez, brother of the unfortunate president, Eulalio, last heard from as a fugitive in the mountains of San Luis Potosí, who up to 1911 worked by the day as an *icil* (maguey fibre) laborer. This year General Luis was sufficiently flush to advance \$1,000,000 to a business partner, General Francisco Coss, who, before the Revolution was a small farmer in Coahuila, but is now established at Saltillo as the *icil* 'king,' using a capital obtained chiefly from his profits for a year as Governor of Puebla. General Candido Aguilar, now Minister of Foreign Relations, was governor of Vera Cruz for some 18 months, and, though just able to write his own name, has found his ignorance neither an obstacle to political preferment nor a hindrance to the rapid accumulation of a fortune of several million dollars, which is now safely banked in the United States.

Of all the Carranza leaders, Dr. Atl is probably the most intellectual; and for long after he first became prominent, in January 1915, his antecedents were a mystery to the public, for he goes under an assumed name. Since then his history has gradually been revealed. Born in Guadalajara, at an early age he developed talent and was sent to Paris to be educated as an artist. While in France, he became interested in syndicalism, and soon became an enthusiastic anarchist. On the fall of the Madero government he joined the staff of

the Paris organ of the Mexican liberal party, and when Huerta fled in 1914, Atl had just landed in Vera Cruz on his way to Mexico City, for the purpose, it is said, of assassinating the tyrant. Balked by Huerta's flight, Atl decided to join Zapata, but on his way to Cuernavaca, he was captured by one of Zapata's generals and condemned to be shot as a spy. Just before the sentence was to be executed, Atl gained a parley with his jailer and such were his powers of persuasion that he not only obtained a pardon, but a safe conduct to Zapata himself. Soon he had become the confidential adviser of the wary brigand, and thus continued for several months until, convinced by his natural shrewdness that Carranza would be the final winner, he escaped to the lines of the First Chief. After various adventures, he finally obtained a job with General Obregon as organizer of his Mexican 1st W. W. Atl has an all-around artistic temperament, and it is as orator and writer, rather than painter, that he has proved himself invaluable to the Carranza ring; for, in the exercise of his unusual talents, he is not hampered by any of those spiritual visions or moral ideals that have rendered so many of the world's geniuses of no earthly use to 'practical' men. The depravity of the triumphal revolutionists is partly explained by the fact that during the advance of the rebels against Huerta in 1913, it was their policy to open the jails of captured towns on condition that the prisoners enlisted as soldiers. And though this policy is not now recognized by the Carranzistas, it is still the custom of the Zapatistas. It is a curious fact that the followers of Villa, the bandit, generally paid for the forage and food they took from the ranchers, while the soldiers of Carranza, the statesman, seldom pay for their forage even now. In fact, the live-stock and poultry of the farms in southern Mexico were long ago declared to be by nature 'Zapatistas,' and therefore liable to capture on sight. In 1914 and 1915 many green crops were either cut for forage or trampled by pasturing horses, and were thus a dead loss to their cultivators. So this year, in spite of the high prices and the decree of 1915 (allowing anyone to cultivate land if the owners do not) only a fraction of the normal average has been planted. This is the case especially in the vicinity of towns garrisoned by cavalry.

The use of Vera Cruz by Carranza as his capital from November 1914 till his re-capture of Mexico City in August 1915 is explained by its manifest advantages as the seat of custom duties and as the port for an easy escape in case his army was defeated by the Convention. But his fixing of his next capital at Queretaro, instead of accompanying his Federal departments to Mexico City, in September, is more of a mystery. It is probable that fear of a re-capture of the City by the Zapatistas and of assassination by some of his political enemies or the relatives of his victims combined to make him shun the Nation's capital as long as possible.

Yet the merchants of Mexico City were told to prepare for Carranza's coming by erecting a line of triumphal arches stretching for the league between the National Palace and the castle of Chapultepec. Where voluntary

subscriptions were not forthcoming to cover the cost of the arches, fines were imposed. Expected in December, Carranza did not arrive until April, and even then he came into town secretly, foregoing a triumphant entry. The following week, the populace was regaled at night with electric illuminations and one afternoon by a welcoming procession of police, soldiers, and peons, collected in the suburbs, which Carranza reviewed from a balcony in the Zocalo. Next day the Government press announced that Carranza was offended by the failure of the professional and commercial classes of the city to greet him with enthusiasm, and that a merited castigation was in store for them. Is it possible that the dreadful financial decrees of June were issued in fulfillment of this threat? Sure enough, on June 5, ₧600,000,000 of genuine notes became practically worthless and thousands of artisans and middle-class civilians, as well as soldiers and servants, walked the streets of the capital with hands

food-growing capacity. Thus there were few city people to be fed from outside, and in the absence of foreign-owned railroads to "intervene," the military satraps could not obtain a monopoly of produce transportation.

Moreover, the exportation of low-priced and bulky foods was a slow affair when they had to be carried from the central plateau to the distant coast on mule-back; and, in the absence of a depreciating currency, there was little profit in exporting even the common produce of the coastal plains. With only coin in circulation, the purchasing power of money was never affected by revolutionary activity, and should the sustenance of one district be depleted, it could easily be obtained in a neighboring district or country with the metallic savings of the inhabitants.

The export of last autumn's crop has left the whole country practically bereft of food, and from the scanty acreage now planted there seems little hope of any les-



A REGIMENT OF MEXICAN SOLDIERS.

full of big notes that would no longer buy them even the cheapest food. The indignation against the Government among all classes was intense and the common feeling was voiced by this overheard remark: "Up to now I had some doubt if our terrible political condition arose from ignorance or dishonesty; but this last decree has convinced me that the Carranzistas are simply hypocritical bandits." Yet there apparently were to be no reprisals or revolts against these bandits by the outraged people, for the simple reason that no Mexican dares to trust another. Thus conspiracies like the Ku-Klux clan of the South or the Vigilance Committee of the West are unworkable in Mexico, and we now find a population of 15,000,000 disarmed and terrorized *pacíficos* being starved and abused with impunity by less than 200,000 Carranzista and Zapatista soldiers, who for years have been having a continual picnic at the expense of foreign investors and the native owners of property. It may be affirmed that no former revolution has ever caused in Mexico such widespread suffering as the present one, for in the old days, preceding 1876, there were no railroads or paper money. Then, the population was mostly rural and was distributed over the land in proportion to its

sening of the famine after this year's harvest, even should the nefarious export operation of the *Casa La Garda* be cut off entirely. In the country the great estates that are still in operation will manage to provide food for their peons, and the small farmers and the Indians of *ejidos* can raise enough for their own use. But the proletariat of the numerous cities is even now in desperate straits and, unless some arrangement can be made for their wholesale feeding by imported food during the coming year, they must soon begin to die like flies, of starvation.

Why Carranza is now trying to provoke the United States to war is not exactly clear. In the light of his own record in particular, and of Mexican character in general, his base ingratitude to President Wilson, who may be said to be the creator of this political Frankenstein, is not at all surprising, but what has Carranza to gain by a fight? Unsupported by the masses, he apparently relies chiefly for safety on a union with Zapata and Villa. Can it be that the fates have relented, and that Mexico, like the Sudan, may now hope for a brighter future after the slaughter of all her banditti has once been achieved at some western Omdurman?

Discrepancies in Cyanidation

By Edmund Shaw

AS SOON as crushing in cyanide solution became a common practice it was found difficult to check the theoretical extraction of the mill with the bullion actually recovered. Sometimes there was a super-recovery, but more often a shortage, for it is a weakness of human nature to estimate on the 'long' side, and one has always to contend with the innate depravity of things. A part of the difficulty must be laid to the new spirit in mining which demanded careful estimates based on observed and recorded fact in the place of guesses. A lot of new problems came up and ways had to be devised to find the answer; for example, the method of figuring tonnage from the specific gravity of the pulp. The mill-man found he had to become a metallurgical book-keeper, or hire one; and sometimes discrepancies persisted and experts had to be called in to find out why.

In order to keep the mill-books straight, a practice has arisen of using what is called the 'bullion plus tailing' method. The sampling of the ore entering the mill is disregarded, the value per ton of the mill-headings being arrived at by adding the value of the bullion recovered to the value discharged in the residues, dividing by the estimated number of tons. Really this is no check whatever upon the work. The only comment necessary is that one large mining company has admitted in a published statement that by using this method there was an unsuspected loss of \$65,000 per year, that was not discovered until better methods of assaying, sampling, and record-keeping were introduced.

The books of a mill should not differ essentially from the books of a manufacturing or mercantile business. The mill should be charged with the value of the ore received from the mine, as determined by the daily sampling, assay, and tonnage determinations, and credited with whatever it produces in bullion and residue. Whenever a statement is made, account must be taken of the ore in the bin and in process of treatment, and of the value in solution and in the precipitation department, etc., and this account must be occasionally checked by stock-taking exactly as a factory checks up its finished and unfinished product on hand. As sampling and assaying are not exact, there will be shown a slight difference on one side or the other, which goes into an account called Unaccountable Loss, corresponding to the Suspense Account of an ordinary set of books. The effort of the mill-man should be to keep this unaccountable loss at a minimum.

The causes of any difference between theoretical and actual extraction will all be found under one of the following:

- (1) Theft.
- (2) Leakage and waste.

- (3) Errors in estimation of tonnage.
- (4) Errors in sampling.
- (5) Errors in assaying.

(1) Theft is suspected more often than it occurs. In a great many years' experience in milling, I have never seen a shortage that could be credited to theft, and in the cases of which I have knowledge the evidence of broken locks and tapped zinc-boxes was so plain that it could not be mistaken. The only places that need protection are the precipitation department and refinery, and it is a simple matter to confine the responsibility for these places to a very few persons.

(2) Leakage in old and badly-built mills may be a serious matter. But few instances are recalled in which this was not the case. The worst was in an old mill, which had leaky mortars. The solution drained away in a dark place behind the mortars and ran into a creek that flowed by the side of the mill. The loss was thought to be insignificant until an assay of the creek-water showed it to carry considerable value. Leaky launders, and launders that overflow from having insufficient grade, account for some loss and a badly-built elevator that stops or breaks down will often cause considerable waste. But, taken as a whole, these are small matters and ones that even the most careless of mill-men will see and remedy. Perhaps the commonest waste about a cyanide mill is that which occurs in cleaning up and refining precipitate. This always amounts to something even where the work is carefully done, and it has been published that losses as high as 6% of the output have been traced to this source.

(3) Errors in estimating tonnage are a frequent source of discrepancy. In large mills such errors can be reduced by the use of automatic machines for weighing and sampling, but the capital cost is too great for the small plant. Weighing and sampling cars by hand is considered too expensive, so the usual method of estimating the tonnage of ore delivered by the mine to the mill is to multiply the number of cars by a 'car factor.' This car factor is obtained by weighing all the cars delivered to the mill-bin over a period of time and sampling them for their moisture content. From the weights and moisture determinations, an average figure is obtained that is henceforth used to determine the daily tonnage by multiplying it by the number of cars for the day. Where the ore is clean and fairly dry, and the mine-cars are all of the same capacity, this method gives reliable figures; but if the ore is wet and sticky, so that the moisture-content of individual cars varies greatly, and the cars do not empty cleanly, it will give unreliable results, especially if the estimation is further complicated by the use of cars of varying capacity. In the case of one such

wet ore, the moisture-contents of cars have been found to vary from 6 to 17%. The amounts left in the cars after dumping varied from almost nothing to nearly 100 pounds. It has happened at the plant referred to, that the car-tonnage has varied more than 10% from the tonnage that had passed the mill during the month, as determined by fairly exact methods.

Another method of determining tonnage, but little used in cyanide mills (except in getting at the work of a particular machine, such as a battery or tube-mill) is the five or ten seconds sample. All the pulp from a battery—for example—is run into a tub or other receptacle, for five or ten seconds, the time being taken by a stop-watch. The average of a number of tests is taken to figure the tonnage per stamp-hour or other unit. Here again the character of the ore has everything to do with the accuracy of the method. It is accurate if the ore is all the time of about the same character, but if the mill is running part of the time on hard quartz and the rest of the time on soft clayey ore that washes through the screen with practically no crushing, it cannot be relied upon.

The best method, and the one now in common use in plants, is that based on specific gravity. In this method the stream of pulp somewhere in its course is run into a tank of known dimensions, and measured and sampled for a determination of its specific gravity. Calculation or reference to a table gives the tons of dry solid in the volume measured. But even then there are opportunities for error. In many cases, the tank is not evenly agitated when the sample is taken. In the ordinary mechanical agitator used as a stock-tank for filters there will usually be found a difference in the specific gravity of the pulp at the centre and at the outside of the tank. It is easy to make a mistake in filling the weighing-flask from the sample if the pulp is at all thin and contains sand. The tank in which the measuring is done will usually be found 'out of round' and allowance is necessary for this in making up the tables. Measurements should be made from water-level to water-level instead of to the bottom of an empty tank, which usually has an irregular bottom of sand. And, finally, care must be taken that slime does not 'build up' on the side of the tank so as to decrease its diameter. An inch coating on a 30-ft. tank represents no inconsiderable amount of dry slime. In a word, those who are in charge of this work must be taught to appreciate its importance and to do it carefully. Most errors in tonnage determinations are cumulative; while small for a day, they may grow into large amounts in the course of a year or even a month.

It is almost too elementary to point out, but it is a fact sometimes lost sight of, that there is often a difference between the car-tonnage and the tonnage passing the battery, and between the battery-tonnage and that which has passed the mill and been discharged as residue. Improper accounting of tonnage which disregards this fact has sometimes shown a serious shortage where none existed. Take the case of a mill that has been running with a short ore-supply for a considerable time. The

mill-bin is empty, storage-tanks and thickeners are 'pulled down,' and everything in solution is precipitated so far as possible. Now, if the supply of ore is suddenly increased beyond the capacity of the mill to handle, the mill-bin will be filled, the stock-tanks and thickeners brought back to the normal running-point, and the amount held in solution will be increased. If at this point a clean-up is made, a large shortage will be shown if the recovery is figured on the car-tonnage, less shortage if figured on the battery-tonnage, and least if figured on the residue-tonnage; and only a complete stock-taking will show the true state of affairs. Probably, every mill superintendent of much experience has had to explain this at some time to a manager or a director. I know of a case in which a small mill was shut-down and everything about the plant cleaned-up in order to satisfy a director that 'something was not wrong,' mere figures having entirely failed to convince him.

A highly important tonnage determination is that of the solution passing the precipitation-department each day. But this presents no difficulty, as it can be accurately determined by one of several methods. The best is the meter, which can be bought or made at the plant, the tilting-box being the usual form. A good way is to run the solution into alternate sumps of known capacity and keep a record of the levels of solution before and after pumping, and, if no other way can be used, a fairly good estimate can be made by measuring with the ever-useful five-gallon can, every two or four hours. In passing, it may be noted that there is no more useful record than that of the quantity and assay-value of the solution going to be precipitated. Properly understood, it is a check on several things and a source of valuable information about the running of the plant. No plant should be run without this record.

(4) The difficulties met in sampling are too thoroughly discussed in the standard text-books to need much emphasis here. The head or feeder sample is the mill-sample that gives the most trouble. If Richards' law is followed, the resulting sample, from ore broken to the size of stamp-mill feed, is so large that the work of crushing and cutting-down appalls the assayer or whoever has it to do. As a matter of fact, it is not necessary to follow this law. A smaller sample may give too high or too low a figure for a single day, but it will be balanced by too low or too high samples in the days following. This is said of mills that run steadily, and on ore that does not vary too much in value, as mills should run. At the same time it is not wise to leave too much to the law of averages; as big a sample as can be conveniently handled should be taken.

Sometimes a sample is taken from each car before it is dumped into the crusher, but this practice is to be condemned. It is impossible to sample ore accurately by grabbing a handful out of a car and if the fine carries a higher value than the coarse ore—as is usually the case, the result will be too high.

Ordinarily, the sampling of the residue presents no difficulties, but I recall two instances in which bad resi-

due sampling led to very serious discrepancies. The first was in a leaching-plant. The tanks were filled by a Butters distributor and no care was taken to keep a head in the hopper. Consequently, the pulp classified, the coarse sand going to one side of the tank and the slime and fine sand going to the other. In leaching nothing was extracted from the slimy side of the tank, but a good extraction was obtained from the coarse sand. The residue was sampled by a split pipe made from an old vanner-roller. It gave a good core from the sand, but almost nothing from the slime. A residue was discharged, supposedly containing only forty or sixty cents, which really contained some three or four dollars. It would be hard to find such an exhibition of ignorance and carelessness in a cyanide-mill today.

The other case was in a filter-plant. The residue-sample was taken by scraping off a little of the cake from a point about a foot below the head of the leaf. In investigating the causes of a discrepancy, a leaf was pulled up and the adhering cake measured and sampled at the top, middle, and bottom. The bottom of the cake was found to be twice as thick as the top, and it assayed three times the value of the top. The information thus obtained went far toward explaining the discrepancy. The reason for this irregular cake-forming was that the crushing was very coarse for an 'all sliming' plant, and the sand in the pulp settled slowly during the cake-forming period.

(5) Mistakes in assays are far commoner than is generally thought, and discrepancies have often been traced to them. A persistent super-recovery has been noted in some silver-mills and explained by the fact that the proportion of loss in cupelling silver is much greater on a large button than on a small one, especially if the work is carelessly done; hence, the head sample is reported too low.

But, far greater discrepancies arise from trying to assay a pulp containing dissolved gold by 'drying down.' Assays made in this way are quite unreliable, a fact that was not generally known until a comparatively recent date. A good many puzzling discrepancies were then explained. If the dissolved value is very low, the loss will be negligible, but if it amounts to as much as 40 cents, a 50% loss may take place during the assaying.

It is the residue-sample that is principally affected by this loss, and there is only one way to avoid it; that is, to wash out the dissolved gold by filtration or decantation, or both, and to assay the washed pulp and the washings separately, and to combine the assays in proportion to the weights they represent. This looks difficult, but the work is not excessive if proper arrangements are made. Where connections can be made with a vacuum-line, the best way is to have a small filter made of tin. This filter has a receptacle for catching the wash drawn through. The residue-sample is mixed with water and a sample taken for specific gravity. To make sure of this, since it is most important to be certain of the proportion of solution and solid, a wide-mouthed bottle, such as a pickle-bottle, may be used for both mixing and weighing.

The mixed pulp is poured on the filter and pulled dry, and the solution taken from the receptacle for assaying. Then the pulp on the filter is thoroughly washed with water, and if the bottle is used, it may be rinsed out with the wash-water. Since the pulp then contains no appreciable value in dissolved gold, it may be dried and assayed like any other ore-sample. To save time, it is usual to prepare a table showing the ratio of solution to solid for different specific gravities, and to use this in making the calculation.

This method is now in use in many plants and has proved itself reliable. An alternative method is to precipitate the dissolved gold with cuprous chloride or other reagent and then to evaporate to dryness. But, in my experience, this has not proved satisfactory. Any assayer can see reasons why it is difficult to cut down a sample containing precipitated gold, not to speak of the slight error that results from adding to the weight of the sample.

Errors in the precipitation-record often come from improper assaying of the solution going to the precipitation-plant. The method of assaying by the use of zinc-dust and lead acetate is simple and in almost universal use, but some care has to be taken or it will give low results.

It may finally be noted that discrepancies are usually found in old and badly-designed mills, and in mills that do not run regularly, either from break-downs or an irregular ore-supply. Steady running on ore of fairly even grade goes far to ensure good checking, as it goes far to ensure good milling in other ways.

THE RUSSIAN EMPIRE is the largest of all countries, having an area of 8,417,115 square miles, which is more than double the area of the United States with Alaska and all island possessions. In population Russia is surpassed only by China and India. In 1913, Russia's population was 174,000,000. Siberia alone has an area twice that of the United States proper and a population of only 10,000,000, equivalent to that of New York State or Canada. It is not generally realized that Russia's cereal and potato crops greatly exceed those of the United States; Russia also has more horses, sheep, and goats than this country, although not so many cattle and hogs, the total of all live-stock being about the same. The Russian Empire has a larger forest area than any other country. Many commercial and business enterprises in Russia have been financed by French capital.

Mining was discussed by A. A. Cole in his presidential address before the Canadian Mining Institute. He said: "Talk to the man on the street and you will be amazed in nine cases out of ten to find that he does not realize the basic difference between a mining and an industrial enterprise. He will tell you that a mining proposition should return twice the income of an industrial concern because it is more risky. He has, in fact, never thought of the extra profit as a sinking fund or return of capital."

The California Gasoline Industry

By W. R. Hamilton

†The knowledge of the existence of petroleum in southern California dates back to the days of the missions. The presence of asphaltum and semi-solid bitumen was reported at Santa Barbara in 1792, but no serious attempt was made to develop oil until Professor Silliman's optimistic report in 1865 started California's first oil boom. Wells were drilled in many counties of the State, but the equipment was unsuitable and the drilling difficult and no production was obtained except in Ventura county. Even there production was of little importance commercially, and not until the early '80s did it become sufficient to again attract attention. In 1888 the production for the State had reached a total of about 700,000 bbl. per year, practically all light oil produced in Ventura county, Pico canyon, Los Angeles county, and in the Puente hills. The production of petroleum attained the dignity of an industry in 1895 when the Los Angeles City and Coalinga fields were discovered. The subsequent development has been remarkable, and in 20 years the production has increased from 1,000,000 to 100,000,000 bbl. per year.

The refining industry has kept pace with the production of oil. The Pacific Coast Oil Co., the predecessor of the Standard Oil Co. of California, was the virtual pioneer refining company of the State, having built a refinery at Alameda about 1880. When purchased by the Standard Oil Co. about 1902, it was dismantled and the refinery at Point Richmond was built. The Richmond refinery is now one of the largest in the world, having a capacity in excess of 60,000 bbl. per day. A small refinery was built by the Union Oil Co. at Santa Paula in the early days of the industry and later many asphalt refineries were in operation in southern California. The Pacific Coast Oil Co. was then, as has been its successor, the Standard Oil Co. of California, the principal refiner and marketer of light products, the most valuable of which was kerosene.

Before the opening of the twentieth century, gasoline of excellent quality was produced, though it was always a drug on the market and was produced for the simple reason that its presence rendered the flash and fire tests of the kerosene too low. The user of kerosene at the present time obtains a safer and better oil than he might receive had not the value of gasoline been increased by the increased demand.

The phenomenal development of the California oil fields in the earlier years of the twentieth century was principally in oils of such heavy gravity that they were

used in the crude state for fuel. During the last six years, which has included the 'gusher' period of the Midway fields, the production of refinable oils has increased greatly, while, strange as it may seem, the production of heavy non-refinable oils has decreased. During this period, from the beginning of the present century, the introduction and perfection of the automobile has changed gasoline from a despised and troublesome by-product to the most valuable and important product of the crude oil. The production of light oils did not keep pace with the demand for gasoline and as a consequence the price of gasoline increased from about 16c. in 1904 to 25c. in 1910. The shortage was reflected in the prices paid for light crude. In the feverish development period which resulted, an enormous increase was shown in its production, until in 1914 the output of light oils capable of being refined was in the neighborhood of 50,000,000 bbl. The resulting gasoline being considerably in excess of the demand, prices began to fall in 1911 and, aided by importations of gasoline from the Dutch East Indies, the price rapidly declined to a low level of 11c. per gallon in the summer of 1915.

The late increase in the price of gasoline is ascribed to the following causes:

1. Decreased production of refinable oil. The decrease probably amounted to about 6,000,000 bbl. in 1915.
2. Steadily increasing consumption.
3. Discontinuance of gasoline imports due to increased European demand.
4. Heavy exports due to European war.

All of these conditions may reasonably be expected to exist for some months to come. There is no reason to expect a reduction in the rate of consumption. The acceleration of the growth of the automobile industry shows no decrease and, with the rapidly increasing mileage of improved highways in California, an increase rather than a decrease may be looked for. It is unlikely that gasoline will be imported from the Dutch East Indies so long as it is possible to deliver it to the European market. The serious shortage of oil in the Eastern and Mid-Continent fields, which developed in 1915, and which resulted in cargoes of gasoline being shipped from California to Europe, does not as yet show evidence of alleviation, and the only prospect of production reaching consumption seems to rest in the discovery of another phenomenal field such as Cushing, Oklahoma. Unless the Eastern fields can increase their production it is to be expected that further exports will be made from California.

There is no doubt that, unless the year 1916 shows a considerable increase in the production of gasoline, which is unlikely, or unless a satisfactory substitute for use in

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†Paper to be presented at the Arizona meeting of the American Institute of Mining Engineers, September 1916.

motor vehicles is provided, we face a serious gasoline shortage on the Pacific Coast.

Increased production of gasoline may come from one of the following causes:

1. Increased production of light oil.
2. Increased production of casing-head gasoline.
3. Lowering the grade of market gasoline.
4. Innovations in refining methods, such as the Rittman, Burton, Snelling, Cosden, McAfee, Wells, Kelsey and Washburn processes.

1. There does not appear to be more than temporary relief to be looked for in increased oil production. All the principal fields have apparently nearly reached the height of their productiveness and while some may increase, the decline of the others will probably outweigh their gain. Unless I am greatly mistaken, the year 1914 will long remain the banner year of California's oil production.

2. The production of casing-head gasoline, which is based on the recovery of the lighter hydrocarbons usually lost in oil production by volatilization, is of recent development. At present it accounts for less than 10% of the gasoline marketed in the State. Owing to the low price in 1913 and 1914, the increase of gasoline produced in the gas industry has been retarded. Several new plants, however, are now under construction. The gas amenable to such treatment is limited, and it is unlikely that the new production of gasoline from this source can be expected to have any marked effect.

3. By lowering the grade is meant including higher boiling-point fractions in the gasoline as the cut is made at the refinery. Before the demand for gasoline was great, the gravity of marketed gasoline was about 65° and even as light as 72° Baumé. The boiling-point of the 'last over' or the end-point of the distillation of such a gasoline was little higher than 200° F. With diminished supply and increased demand, the gravity has been gradually decreased until the present standard is from 59° to 61° Baumé with an end-point from 320° to 380° F. The cut in the refinery distillation is, therefore, widened and the production of marketable gasoline produced is thereby increased. If no other way is found to supply the demand, this cut can be widened still further while continuing to furnish the motorist a satisfactory fuel. The production can probably be increased from 30 to 50% in this way.

4. The processes mentioned show considerable promise. They depend for their success upon being able to break up the molecule of high boiling-point hydrocarbons into lower boiling-point molecules. The processes may be divided into two main classes, those which depend upon excessive heat or pressure or both and those which depend upon a catalytic agent.

The most notable of the former are the Burton and Rittman processes. The Burton process, which was patented by William M. Burton in 1912, is controlled by the Standard Oil Co. After many difficulties have been overcome and much money expended in experimental work, this process has been made successful and is now

being installed in many Standard Oil refineries. Much difficulty was first encountered in producing an article that was of good color and odor. This has been overcome and the Burton process now gives the Standard Oil Co. an important advantage over its rivals. So far, it has not been successfully applied to California asphaltic oils where the presence of a large proportion of unsaturated hydrocarbons results in difficulties not experienced with the oils from the Eastern fields.

The Rittman process is the result of the research work of W. F. Rittman of the U. S. Bureau of Mines. The process has already been successfully applied to the commercial manufacture of toluene and benzene. It differs from the Burton, Snelling, Cosden, Washburn and Wells processes, in that the action takes place after the liquid has been vaporized. By subjecting the vapor to pressure and heat, a re-arrangement of the molecules is effected, liberating carbon which is removed from the plant without difficulty. The process shows much promise and, while much remains to be done before it can be considered a commercial success, it has created a profound impression among refiners. Under the rulings of the Government, a Federal employee may not profit in this country from any discoveries or inventions during his connection with the Government. The foreign rights will be controlled by Dr. Rittman. The Government proposes to allow anyone to use the process under license, and it is probable that the increased value of gasoline and the handicap confronting the 'independent' refiners on account of the Standard's control of the Burton process will result in an early attempt to perfect the process. It has been perfected as far as is possible in the laboratory stage and its future depends upon the results of its application on a practical scale.

Of the processes making use of a catalytic agent, the McAfee process, which is controlled by the Gulf Refining Co., is the most promising. The catalytic agent is aluminum sulphate, and results from experimental work are said to be excellent. However, this process, like the Burton, will probably be unavailable to other companies.

The future has generally cared for itself and will undoubtedly do so in the gasoline industry. While we shall probably have a gasoline shortage extending well into 1916 and perhaps into the early part of 1917, the result will be redoubled interest in the subject of perfecting such ideas as have been brought to light in the experimental work done in the above-mentioned processes. The research work of Dr. Rittman and other able scientists who are working on the problem, bids fair to develop a practice which will revolutionize the refining industry.

GOVERNMENT reports, it is suggested by R. E. Hore, would be more read if they were more concise. Verbose publications are likely to be thrown away or shelved. A considerable saving could be made by intelligent editing or even by changing the usual wasteful typographical arrangement.

Silver

Silver prices are fairly high, but those who watch the market may note by the fluctuations that it is sensitive. According to Messrs. Pixley & Abell of London, China and India are still the cause of weakness, and sales from one or other of these quarters have been in evidence almost daily, with the result that large buying orders for coinage have been easily filled. So much depends on the attitude of China toward this market that the immediate future is most difficult to forecast. Looking farther ahead the prospects statistically seem favorable for the following reasons:

(1) The low level that the stock of rupees in the currency reserve of India has reached, in spite of purchases amounting to some millions sterling, a good deal of which has already passed into currency, points to a continuous drain on this reserve, and it seems probable that the Indian government will have to continue coining for some time to come. (2) The British mint's requirements will probably continue. This year £2,200,000 has been absorbed for coinage in England. (3) The demand for silver by the Allies is likely to be maintained so long as the War lasts. In spite of important purchases, the stock of silver in the Bank of France has been reduced by £1,000,000 during the past year. (4) The probability of the retention in the country of a large portion of the Mexican production for the purpose of re-establishing the currency. (5) It is questionable whether China, having already sold such large amounts of silver, is in a position to part with much more. According to latest advices the stock of 'sycee' (60-oz. bars) in Shanghai is reduced to 26,000,000 taels (35,500,000 ounces). (6) The world's production of silver is decreasing. In 1915 the total production was estimated at 196,000,000 fine ounces, against 211,000,000 in 1914. For these reasons the future of the market, from a purely statistical point of view, seems favorable.

Regarding Egypt as a factor in silver, the Egyptian correspondent of the *Pioneer Mail*, on March 10, wrote as follows: "Every year we have a silver 'crisis,' usually in the early autumn, when large numbers of laborers have to be paid daily throughout the country in connection with the cotton crop; but the crisis usually is over by Christmas, being met by imports of newly minted coin that has to be obtained in the ordinary course. The War has, however, completely changed the situation. The increase in the army has necessitated the putting into circulation of far more nickel and silver currency than ever before, and the financial authorities took early steps to obtain the necessary extra supply. Things would not have been so bad if the shipments in the *Persia* and the *Malaja* had not been lost. During 1915 new coin to the value of £720,000 was imported, whereas the average of the preceding five years had only been £140,000, and the previous recorded maximum annual import was £694,000 in 1896, when the system was remodelled. The Sudan, it should be mentioned, uses the same currency as Egypt and a good deal of British gold

and Egyptian silver remains every year in the interior of that dependency. India appears to have been the only part of the Empire that had any silver coin to spare, and by special arrangement the Egyptian government imported a certain quantity of silver rupees, which, it is stated, have now been declared legal currency in the country. Whether in order to facilitate trade between Egypt and the Sudan, they will also be made legal currency in the latter dependency, is not known."—Abstract from weekly letter of Samuel Montagu & Co., London.

THE SILVER production of the world has averaged about 200,000,000 oz. per annum, worth approximately \$100,000,000, since 1900. This compares with an average annual output of gold during the same period of more than \$400,000,000, or four times the annual value of the silver. The world's output of silver in 1915 is estimated at 196,000,000 oz., of which the United States produced about one-third, Mexico, Central and South America another third, and Canada one-seventh, the remainder being contributed by Australia, Japan, and other countries. The figures for the world's yearly production of silver since 1860, issued by the Director of the U. S. Mint, show that the increase has been gradual, from 29,095,428 oz. worth \$39,337,000 in 1860 to 211,339,749 oz. worth \$116,849,900 in 1914. But from 1893 to 1906 the output remained practically at a standstill; in fact, the production in 1893 was worth slightly more than that of 1906, the value being \$129,119,900 in 1893 against \$111,721,100 in 1906 for approximately 165,000,000 oz. in both years. This was due to the decline in the silver market. In 1912, when the production of silver reached 224,310,654 oz. worth \$137,883,800, the value was but little greater than in 1891, when the output of 137,170,000 oz. was worth \$135,500,200. The recent rise in the price of silver was explained in a nutshell by Samuel Montagu & Co. of London, as follows: "The quotation fell quite as heavily when silver was demonetized upon a large scale; now an exactly reverse operation is taking place. Silver is being monetized upon a large scale."

JAMES J. HILL's comment on financial and national questions was always interesting and usually sound. In a letter written just before his death, and printed in the *Analyst*, he said, regarding the nation's banking system: "There should be one and only one Federal Reserve bank for the United States. This should be located at Chicago, the central city of the country, where it would be safe from danger of naval attack in case of war. It should be the centre and directing influence in financing the business of the country, dealing of course only through other banks. There is much less danger of abuses from a single central bank than from a dozen local banks. The division of the country into districts, drawn haphazard, was and is a mistake from every point of view."

EXPORTS from the United States to the extent of 10% in value, or 35% in bulk, are carried in American ships.

CONCENTRATES

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

GERMAN SILVER contains 60% copper, 21% nickel, and 19% zinc.

LOCOMOTIVES on 40 railroads in the United States use oil for fuel. In 1915 there was 36,648,466 bbl. consumed in this way.

Loss of copper in tailing and slime at Anaconda before flotation was introduced was about 16 lb. of copper per ton. Since the introduction of the flotation process, the loss does not exceed 1½ lb. per ton.

SERBIA has one good copper mine, the Bor, operated before the War by a French company that paid 60% in dividends for several years. The ore resembles that of Butte and averages 6% copper. The output was 7500 tons of metal per annum.

AN AEROPLANE is used to make daily trips from tide-water to the Dolly Varden mine, 14 miles inland in British Columbia, says a newspaper report. This is for sending supplies to the mine, and the service is said to be rendered by the California Aeroplane Co. for \$600 per month.

FOR TEMPERING drill-steel it is good practice to have a wire netting several inches above the bottom of the tempering-tank. This prevents the bit, when being cooled in the bath, from standing in the accumulation of sludge in the bottom of the tank. Breakage of drill-steel used in hammer-drills is increased by continuing to use bits after they have become dull.

THE VISCOSITY of different furnace slags is being investigated by the U. S. Bureau of Mines at Pittsburg. An apparatus has been devised to measure the viscosity of slags by a torsion method, the torque being indicated by a mirror and scale. Several surprising facts, contradictory to the ordinary properties observed by the eye, have been disclosed by the measurements.

PYRITIC SMELTING and its advantage was first suggested by John Hollway, who pointed out that copper ore from Rio Tinto, Spain, containing much iron pyrite, could be smelted by the heat mainly derived from the oxidation of the iron and sulphur. Later, in Tasmania, Robert C. Stiehl applied pyritic smelting to Mount Lyell ore. The Tennessee Copper Co. further perfected the practice, under the direction of W. A. Heywood. Only a small addition of coke to the ore is required, about 2%.

'HIGH-SPEED' TOOL-STEEL, so-called, containing tungsten, chromium, etc., is not as hard as ordinary high-

carbon steel, and usually can be scratched with a good file. Its resistance to cold wear is less than that of heat-treated high-carbon steel. The special property of 'high-speed' steel, such as tungsten-steel, lies in the fact that it may be used at a speed six times faster than ordinary carbon-steels, without being softened by the frictional heat.

DETERIORATION of an explosive comes from storage in a climate where rapid changes of temperature are usual, as hot days and cool nights. The explosive assumes a dark color and loses its elastic consistence. Nitroglycerine separates from the compound and shows as an oily layer on the paper wrapper. When an explosive has been stored in a moist place, a fine salty powder of saltpetre becomes crystallized on the wrappers. Such explosive should not be used, as the uniform intermingling of the constituents has been changed.

USE OF POWDERED COAL for generating steam is still in the experimental stage. Steam can be efficiently produced by this method, as regards combustion and evaporation. The loss in the ash-pit and the flue is less than 1%. The cost of fuel preparation, however, is high, and conditions have to be favorable for the practical use of powdered coal. The great success of powdered coal lies in its adaptability for metallurgical furnaces, as in the coal-dust firing of large reverberatories at Anaconda and Garfield, and for the firing of locomotive-boilers.

AERIAL TRAMWAYS are well liked for transporting ore over rough country. The cost of moving ore by this method where the distance is 2 to 5 miles is usually not more than 3 or 4c. per ton-mile, say 8c. for moving the material 2 miles and 12c. for moving it 5 miles. For shorter distances the cost does not decrease much, as the expense is principally at the terminals. However, in a well-regulated tramway less than a mile long, operating with self-dumping buckets, the cost may be as low as 4c. per ton. Where only a small quantity is handled, say 100 tons per day, the cost becomes relatively high, because over-head expense is proportionately large.

BOILER EXPLOSIONS in the United States during 1915 totaled 404. There were 132 deaths and 236 injured persons therefrom. In California 9 explosions were reported, causing 7 deaths. Tentative boiler safety-orders have been prepared for this State. The code covers the subjects of inspections, ultimate strength of material used in computing joints, minimum thickness of plates and tubes, specifications of metals used in building boilers, construction and allowable working pressures for power boilers, riveting, caulking, requirements for man-holes and wash-out holes, safety-valves, water and steam gauges, fittings and appliances, hydrostatic tests, etc. The boiler code of the American Society of Mechanical Engineers has been incorporated and made a part of the tentative orders, with a few changes affecting existing installations only.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

BUTTE, MONTANA

ZINC MINES AND PROSPECTS AT BUTTE.

The following notes and map give a good idea of the zinc possibilities of this well-known copper region:

The Butte & Superior Mining Co. (formerly the Butte & Superior Copper Co.) is hoisting 56,000 tons of 17% zinc ore per month through its Black Rock shaft. The two new shafts that are being sunk in the Black Rock claim are down 700 ft. One of them has already been raised from the 1400-ft. to above the 800-ft. level. The remaining ground will be taken out and the shaft completed from the surface to 1400 ft. by July 10. Foundations of the two new electric hoists are being prepared. It is expected to have both new shafts in operation this year. With three shafts the company will have the best hoisting facilities at Butte, and production of the B. & S. need never again suffer from inability to hoist ore or lower timber. More extensive development can also be carried on, as there will be better arrangements for transferring waste from one level to another. The mill is near the mine, and an extraction of about 93% is obtained by concentration and flotation. This recovery will be improved by changes now being made. The monthly concentrate contains 16,500,000 lb. of zinc, 340,000 oz. of silver, and 250,000 lb. of lead. The company has purchased the Mastodon claim, north of the Butte-New York ground, which is controlled by the B. & S. No development is being done in the Butte-New York claim at present. The B. & S. was the first at Butte to develop a large quantity of zinc ore. The large block-quartz manganese outcrops were worked in the early days for silver. Later, the predecessors of the present owners organized a company to explore the veins at depth in the hope of finding copper. No copper ore was found, but large bodies of sphalerite were disclosed. It then became necessary to find a satisfactory method of treating the ore. The mill feed averaged 17% zinc, and smelters would not buy concentrate in which the percentage of zinc was less than 50%. Development of the flotation process has been an important factor in the solution of the milling problem. Concentrate is still being shipped to smelters in Kansas and Oklahoma. In a recent interview, D. C. Jackson, managing director of the Butte & Superior, said:

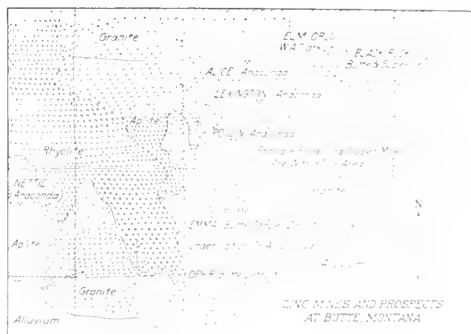
"Since acquiring the Butte & Superior property about five years ago, we have mined more than 1,250,000 tons from the upper levels and yet there is today more than double the tonnage in sight on those levels than was calculated as fully developed when we took over the property. I refer particularly to the levels above the 16th. We have done much development work on the 17th and a limited amount on the 18th; and have opened on these levels in the east end of the property, in virgin ground, more ore than was in sight in the entire property when we first started operations. Orebodies of the Black Rock claim are extending east far beyond the boundaries of the Black Rock into the Four Johns claim. So large now are the ore reserves of the Butte & Superior that the company can go on producing indefinitely at the present rate of 180,000,000 lb. of zinc annually. Butte & Superior can produce metal at less than 4c. per pound, and even should the spelter market drop back to 6c. the company can make a profit of 2c. and earn per share better than \$12 annually."

The Elm Orlu adjoins the Butte & Superior ground on the west. The same large lode extends through both properties. The ore is the same in character and grade as the B. & S. ore,

and the process of treatment is also similar. The mill is situated on the opposite side of the city and ore is handled in 50-ton railroad cars. About 800 tons of ore is hoisted daily; this quantity will be increased materially when the new electric hoist is installed. The new hoist-house is being built of steel and brick, and is practically half completed.

The Elm Orlu Mining Co. reports that it mined 200,752 tons of zinc ore, averaging \$18.52 per ton. The gross value was \$3,717,498. Expenditure included \$1,011,537 for mining, \$1,783,352 for milling, \$408,823 for transport of concentrate to smelter, and \$18,029 for construction. The net profit was \$495,757, during the year ended June 30, 1916.

The Anaconda Copper Mining Co. is making 25 tons of high-grade spelter per day by its new leaching process at Anaconda. The Lexington and Poulin mines are supplying most of the ore for this plant. The ore is graded up to 15% zinc at the mines, 180 tons being mined each day. The company has several other mines that will be called upon to furnish zinc ore for the large leaching plant that is being built at Great Falls. Occasionally cars of ore are sent from these mines to the Anaconda experi-



mental plant for testing purposes. The ore is concentrated and then leached with sulphuric acid. Some of the iron and copper goes into solution also, but the lead and silver remain in the residue. The iron is precipitated with lime and the copper with zinc dust. The zinc in solution is then precipitated by electrolysis. The zinc is deposited in spongy form. The cathodes have knobs and irregularities on them, similar to those formed in the electrical precipitation of copper; cathodes are melted and cast into molds. Concentration of the zinc ore will be done at Anaconda, and the product shipped to Great Falls for leaching. If the ore could be milled at Butte it would eliminate 50 miles of railroad haul, but there is a scarcity of water here; for that reason the large copper works of the company were built at Anaconda. The Butte & Superior is obliged to buy water from the city water system, although all of the water that is pumped from the mine is used in the mill. The Timber Butte mill, in which Elm Orlu ore is treated, gets its water from artesian wells in the flat south of the city.

The Alice is a famous old silver producer that was recently purchased, and it is now unwaterved to prospect for zinc ore. It is on the same large lode that goes through the Butte & Sa-

perior and Elm Orlu properties, and its chances of developing into a large zinc producer are considered good. The shaft has already been re-timbered to the 600-ft. level.

The Nettie, another old silver producer has been unwatered and repaired to the 500-ft. level. It is situated on the western edge of Butte, and there has been no deep development near it. The silver ore, however, will doubtless pay for re-opening the mine, which has an excellent chance to become a zinc producer when opened at depth. For over two weeks the Nettie has been making regular shipments of ore. Two ore-bins are under construction at the mine.

The Lexington mine was formerly controlled by the late F. A. Heinze. It has produced considerable silver and copper. Exploration and development of zinc ore is being carried on with satisfactory results. The Lexington is expected to be one of the big zinc producers of Butte.

The Pilot will also be a zinc producer. This fractional claim of six acres was purchased from the Pilot Butte company for \$1,125,000 cash. The claim is near the Butte & Superior, and contains both zinc and copper ore; but much of it was tied-up in the litigation that resulted in the sale of the property. There is a three-compartment shaft down 2650 ft. Mining will be resumed as soon as the new hoist is installed.

Among the Anaconda company's mines that have been copper producers in the past and in which zinc ore is now being blocked-out may be mentioned the East Colusa, Gray Rock, and Poulin. They will be in a position to hoist ore when the Great Falls works are completed.

The Emma belongs to the Butte Copper Zinc Co., but is being opened by the Anaconda company. The shaft is down 800 ft., and development is under way on that level and also at 200, 400, and 600 ft. Considerable zinc ore has already been blocked out, but it is a lower grade than that found in the northern part of Butte, and sorting will have to be resorted to if an average of 15% zinc is to be maintained. A cross-cut is being driven on the 1600-ft. level from the Gagnon, and as soon as it reaches a point under the Emma shaft raising will begin. A new hoist capable of hauling ore from a depth of 3000 ft. has been installed, and the work of sinking the shaft to meet the raise from 1600 ft. will be begun immediately. The Butte Copper Zinc Co. has 500,000 shares issued. Anaconda took over 100,000 shares at \$1 each on April 5. It has a further option on an additional 88,000 shares good until July 10, and contingent on opening of the mine to the 1600-ft. level. Including shares bought in the open market, it is surmised that Anaconda will have a majority interest in the Emma mine. The Anaconda and Butte Copper Zinc companies share equally in the profits of the Emma for five years more, which virtually gives Anaconda 75% of the profits.

The Butte Detroit Copper & Zinc Mining Co. was organized by Philadelphia, Boston, Detroit, and Canadian capital to take over the Ophir mine and mill from the Butte Central Copper Co. The Ophir produced some silver ore, and a 150-ton mill was erected to concentrate and cyanide the low-grade ore. The mill is in good condition, is on the Butte, Anaconda & Pacific tracks, and may be opened as a custom mill. The equipment consists of a gyratory crusher, Chilean mill grinding to 24-mesh, and five Deister tables. The tailing goes to Akins' classifiers and the sand product to a tube-mill, then to a cone classifier, the underflow feeding 8 Deister slime-tables. The tailing is dewatered and sent to the cyanide plant, which consists of Akins-Rotherwell continuous agitation tanks, Portland filters, and zinc-boxes. The three-compartment shaft was down 1065 ft., is now being sunk and will be ultimately opened to a depth of 2500 ft. The vein will be thoroughly explored at depth in the hope of finding zinc or copper ore. The old hoist is capable of working to a depth of 1500 ft. A station hoist will be put in at that level and later, if conditions warrant it, a new hoist will be installed. The Ophir contains a large, strong vein, and some zinc has been found on the upper levels. The Anaconda continues to develop its Douglas mine in Idaho.

PLATTEVILLE, WISCONSIN

ZINC, LEAD, AND PYRITE MARKETS IN JUNE.

Reports covering June operations in the Wisconsin zinc districts show intensified activity in all departments. A gradual lowering of the price of zinc ore in no way discouraged operators, many of whom frankly admit the day of sky-high prices for blende is over, and that the new adjustment of prices must be met with sense. Blende averaged \$88.12 per ton in May; in June the average was \$78.12, but the drop of \$10 per ton applied more nearly to the prices ruling on standard 60% concentrate. On the lower-grade products discrimination was so sharp that on the low values no offerings were submitted by ore-buyers, and the close of the month found 8000 tons of concentrate unsalable, and likely to remain a drag on the hands of independent operators until by pre-arrangement this material can be diverted to separating plants doing custom work, and the ore converted into high-grade material. The New Jersey Zinc Co., nevertheless, producing heavily from its own string of mines in the field, offered an outlet to much independent production, and the National Zinc Ore Separating Co. and the Wisconsin Zinc Co. received low-grade ores from mines not connected with these corporations. On the lower grades the following list of prices obtained: 55%, \$75; 50%, \$45; 45%, \$40; 40%, \$35; 35%, \$31, and 30%, \$25. Below 30% no buying was recorded, and there are many producers in the field whose average grade falls below this figure. Some of the higher-grade ore was carried over as well, but this was due to the belief that prices would recover, enabling operators to realize on their holdings to better advantage.

Heavy rains prevailed at all points in the field from the 10th to the 20th of the month, making ore deliveries to track almost impossible. Production was fairly well maintained, going over 40,000,000 lb. of crude concentrate, though curtailed output was manifest among producers who learned that no market was at hand for low-grade concentrate. Net deliveries out of the field to smelter direct exceeded 20,000,000 lb., the greater part of this being high-grade refined ore from the magnetic zinc ore-separating plants operating in the field. The Mineral Point Zinc Co. during the month of June shipped to smelter at DePue 5,012,000 lb. of high-grade separator product; National Separating Co., Cuba, 4,020,000 lb.; Wisconsin Zinc Co.'s roasters at Benton and Galena, 3,638,000 lb.; and Galena Refinery Co., 1,160,000 lb. The Frontier group of zinc producers shipped 1,581,000 lb. out of the Benton district to the Grasselli Chemical Company.

The wage question arose during June, several leading operators claiming that lower prices for zinc ore will surely determine a lower wage-scale. Men of all classes in the field are being well paid and no reductions have been intimated as yet, but agitation at times dwelt on this feature of the industry with prospects of probable trouble. Many new zinc mines were developed during the month. Several new power and concentrating plants were completed at different points, and given satisfactory trial-runs. More drilling machines were worked night and day than were reported a year ago when prices were so high. Strikes of rich deposits were numerous, and leasing was again in great favor, more especially in the southern districts.

Lead ore was in good demand at the beginning of the month at prices running well up to \$90 per ton. Here, too, appreciable declines were registered, and the price at the close of the month stood below \$80 per ton for 80% ore. Sales and shipments were light and a fair quantity was carried over in bins.

Shipments of pyrite were the lightest of any one month for the year, namely, 2,556,600 lb. This all came from the National Zinc Ore Separating Works at Cuba. In this instance the shipper was protected by a contract wisely drawn at a time when the fine pyrite obtained as a by-product at magnetic sep-

arating plants was in good demand. At all of the other separating plants in the field this by-product was carried over, amounting at the end of the month to millions of pounds. With prices for commercial sulphuric acid high, the lack of demand for this class of material seemed all the more inexplicable, and the general manager of one of the leading plants offered what appeared a satisfactory explanation: The tremendous increase in acid-making capacity in the United States was given as one reason, but the more plausible reason was given in high prices for spot acid, which makes it more profitable to use native sulphur from the mines of Louisiana and high-grade sulphur ore giving larger acid recovery. The acid department of the New Jersey Zinc Co. at Mineral Point increased its capacity sufficiently to yield one 25-ton tank-car daily, which was promptly routed out to the United States Steel Corp. and other Eastern outlets. At the same time the New Jersey Zinc Co. gave notice of reduced prices in zinc oxide to take effect July 1. Heavy importations of Mexican calamine ore and Canadian carbonate of zinc ore were also reported for the month at the oxide works of this company.

Producers of carbonate of zinc ore in the northern districts of the field were favored by rain, and plenty of water for outdoor washing-plants increased local production.

TORONTO, ONTARIO

COPPER AND GOLD IN MANITOBA.—DOME, HOLLINGER AND OTHER PORCUPINE MINES.—COBALT ACTIVITIES.—KIRKLAND LAKE POWER.—BOSTON CREEK.

Mining is making great progress in Manitoba this season. A rush to the Rice Lake district has set-in, and numerous companies have been organized to operate there. The copper area north of The Pas is also attracting much attention. The discovery last year of valuable copper deposits, by Jack Hammill, a well-known Toronto prospector, 110 miles north-west of The Pas, near the eastern boundary of Saskatchewan, has been taken over by the Guggenheim interests of New York, who have commenced development. They have three drills at work, and have blocked-out ore estimated at \$25,000,000. The Tonopah Co. of Nevada is operating along the same copper ridge, farther to the south-east, and opening rich ore. The mineralized ridge extends from the north-west part of the province in a south-easterly direction to Herb lake, 175 miles distant, where rich gold claims are being developed by a syndicate headed by the Hon. Hugh Armstrong, formerly provincial treasurer of Manitoba. But little prospecting has so far been done in the central part of this area, which is thought to be rich in copper. As in the case of the Rice Lake goldfields, development is much retarded owing to the lack of railroad facilities. A mining exchange is to be operated for dealing in local share issues in Winnipeg early in July; probably at a later date it will obtain facilities for trading in Eastern stocks. R. C. Wallace, provincial mineralogist, is making an inspection of the Rice Lake field; an official report will shortly be issued.

The Dome company at Porcupine made a new high record in May, milling 39,400 tons, yielding \$189,600, from an average grade of \$4.80 per ton.—The statement of the Hollinger for the 4 weeks ended May 19 shows gross profits of \$154,369, from the treatment of 33,558 tons of ore, averaging \$8 per ton. Working costs were \$3.33 per ton. Considering the heavy advances in the cost of materials, particularly explosives, the reduction of costs to this figure is considered excellent.—The Nipissing of Cobalt is taking over the Plenaunum property, in which some of its officials are largely interested.—The West Dome is improving with depth. At 250 ft. a shaft sample was taken from a width of 7 ft. 6 in., which gave \$41.20 per ton. Two other veins have been cut in diamond-drilling.—During May the Schumacher produced billion to the value of \$20,908, with net profits of \$6060. Some 200 ft. of driving has been done on one of the new veins found on the 600-ft. level. It is about 6 ft. wide and is of good milling grade.—A merger

is being arranged between the Vipond and the Huronian Belt company, which controls the North Thompson. The latter mine has good ore on four levels, but has been unable to obtain funds for the erection of a mill. It is proposed if the deal goes through to enlarge the Vipond mill to a capacity of 400 tons per day.

Silver mining at Cobalt is busy; many properties that had been closed for some time are again being worked.

Work has been started on the 65-mile transmission line of the Northern Ontario Light & Power Co. from Cobalt to Kirkland Lake. It is expected that the company will be able to deliver power to the latter plants early in September. This will give a great impetus to gold mining.

The Boston Creek Gold Mines, Ltd., capitalized at \$2,000,000, of which F. M. Richardson of New York is president, has taken over the holdings of the R. A. P. Syndicate at Boston Creek including the townsite. H. D. Symes has been appointed manager.

SUTTER CREEK, CALIFORNIA

MOTHER LODE ACTIVITIES.

Daily progress in unwatering and repairing the old Eureka shaft is 20 ft., and since the pumps began discharging about the middle of June, the water has been removed to a point 240 ft. from the surface. The shaft-timbers are found to be in a good state of preservation, many of the sets simply requiring a little timber and a general lining up. This fact, coupled with the successful operation of the pumps, accounts for the good progress being made.

The new mill at the Treasure mine began crushing on July 5 and appears to be giving good results. The plant is using Hardinge ball-mills instead of stamps. The crusher is on a high reinforced concrete frame vertically above the mill ore-bins. Below the crusher is a trommel. The trommel over-size goes to a ball-mill using large steel balls. The trommel under-size, together with the ball-mill discharge is screened on 16-mesh. The screen over-size is ground in ball-mills using small steel balls. The flow-sheet of the lower part of the mill is much like that of the Plymouth. A shaking amalgamator, Wilfley tables, Deister-Overstrom tables and Frue vanners are used. It is stated on good authority that the ore-shoot cut in sinking the shaft last year has widened out to such an extent that there will be no difficulty in keeping the plant employed steadily on good-grade ore. This mine is situated between the Bunker Hill and Fremont properties, north of Amador City.

Construction of the new Argonaut mill is well under way, a large part of the machinery having been installed and the building near completion. Much of the iron-work for this new mill has been made at the foundry of the Knight company at Sutter Creek. C. G. Cahill, one of the contractors, has been in Jackson for several days past, supervising installation of the crushing plant. While several new devices for saving gold will be introduced at this mill, the company does not contemplate the use of ball-mills nor of flotation. While the new equipment is being erected, the old 40-stamp mill east of the shaft continues to reduce some of the highest grade ore being treated in the county. The lowest levels of this mine are fully as valuable in ore reserves as the levels above.

Sinking is in progress at the Kennedy mine, good progress being made from the 375 to the 390-ft. level, vertical depth. The 100-stamp mill is in constant operation on ore extracted principally from the lower levels. The old north shaft is kept open in addition to the main east workings, thus affording a safety exit as well as better ventilation, and serving also as a supply channel for getting supplies to the working levels. Webb Smith is still superintendent of this mine, which is paying its shareholders good quarterly dividends.

J. E. Sattler, well-known in mining circles in Amador county, and in Humboldt county, Nevada, lost his life in an automobile accident which occurred on July 2 near an antimony mine in which he was interested at Unionville, Nevada.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

In its mid-year reports on the mining industry the U. S. Geological Survey makes the following remarks:

The mines and smelters of Arizona have been working at so high a pressure in 1916 that they are probably making record productions of all metals. If they continue to work at the present rate during the year they will make an output of over 600,000,000 lb. of copper, against about 450,000,000 lb. in 1915. There is much greater activity in gold and zinc mining.

There has been much greater activity in the mining industry in California for the first six months of the year, as compared with the conditions in the first half of 1915, but it has been largely in the direction of the re-opening of old properties which have been idle for years. Less gold, by \$366,000, has been received by the Mint and smelters. Aside from gold, silver, copper, and lead mining there has been thus far in 1916 a heavy demand for such minerals as chrome, tungsten, magnesite, manganese, antimony, etc., and a great many mines of this character have been opened and are shipping some to the East for the first time. There has been greater gold-mining activity in the Mother Lode counties than has been the case for a long period. Hydraulic mining has not been active outside of Trinity and Siskiyou counties, but some new mines have started up in central California. The gold-dredging industry continues in a flourishing condition. Copper mining has been very active owing to the high price of the metal.

During the first six months of 1916, according to returns received by the Survey, the output of Colorado indicates a 15% decrease in the yield of gold, little change in the production of silver, a small increase for lead, an increase of 30% for copper, and a small increase for zinc.

Unusual conditions in Idaho make it impossible to estimate accurately the lead output of the State, but shipments are being made at the rate of about 360,000,000 lb. of lead per year. There will be a correspondingly large output of silver, and a great increase in the total value of the State's output of metals. Important changes are in progress in the metallurgical industry.

The unusually high prices of metals in 1916 have stimulated mining to a marked degree in Montana, especially at Butte. At the present rate of production, there will be notable increases in the output of all metals, and a marked increase in the total value.

Mine reports received by the U. S. Geological Survey from V. C. Heikes of the Salt Lake City field office indicate that during the last six months the mining industry in Nevada has experienced one of its greatest revivals. Gold will show little increase; silver may gain; lead, copper, and zinc will record big increases.

The mines of New Mexico during the first half of 1916 show small increases for gold and silver, and appreciable increases in lead, copper, and zinc.

No changes of moment in the mining situation in Oregon are noted by Charles G. Yale, of the Survey, for the period under review. The bullion receipts of the Mint and smelters at San Francisco show that the output of gold has increased \$107,000 and that of silver 11,000 oz. In the first five months of 1916 over the output of the corresponding period in 1915. The increase in gold is due entirely to dredging operations.

High prices of metals during the last six months caused Utah producers to employ all available miners extracting ore. In some of the snow-bound camps large quantities of ore were

stored during the winter months, and when this was released to the buyers a curtailment was requested by the smelters of all producers exceeding contract limits.

The mines of Washington, for the first 6 months of 1916 promised increased production in the five important metals for the year. The industry generally seems to be in better condition than for several years past.

ALASKA

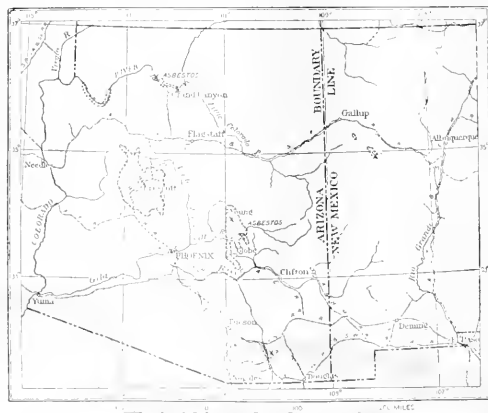
In Professional Paper 98-C. of the U. S. Geological Survey, Bertrand T. Johnson discusses the retreat of the Barry glacier near Port Wells, Prince William sound, during the years 1910 and 1914. The total retreat was 8200 and 2500 ft. respectively along the eastern and western edges.

JUNEAU

The June output of the Alaska Gold Mines was 164,800 tons of \$1.06 ore, compared with 175,215 of \$1.40 in May, and 165,930 of 94 cents in April. Recovery in June was 79.25%, with 22-c. tailing; the May extraction was 82.25%. None of the better grade ore from No. 5, 6, and 7 levels east reached the mill until June 17. On July 3 there was treated 8700 tons, a record. Shares have receded to \$16.75.

ARIZONA

An order-in-council by the Canadian government on March 25 placed an embargo on the shipment of asbestos from Canada to other than British ports, but permitted shipments to the allied countries on special license. This looked like a great hardship on American manufacturers, but it means much to the owners of asbestos mines and prospects in Arizona, says



MAP SHOWING ASBESTOS MINES AND PROSPECTS IN ARIZONA. SHADING SHOWS AREAS OF PRE-CAMERIAN ROCKS. (U. S. G. S.)

the Arizona State Bureau of Mines. In 1915 there was a great increase in the production of high-grade asbestos in Arizona, most of the lower grade in the country coming from Georgia. The embargo creates a local demand and Arizona is one of the few States that can supply it. With the opening of the

Arizona asbestos mines and the production of asbestos on a stable basis, when the embargo is removed, Arizona will be able to compete with Canadian asbestos, which heretofore has supplied the greater part of the world's supply.

GILA COUNTY (MIAMI AND GLOBE)

Churn-drilling has been resumed by the Inspiration Needles Copper Co. at Miami; eventually 7 drills will be operated. During the last week of June there was laid 4800 ft. of 2-in. water-pipe, which is connected with the pumping plant of the Miami Southwestern, and which will supply adequate water to the two churn-drills now on the ground. All lumber and material is ready for the erection of mess and boarding houses, blacksmith-shop, assay-office, and the general offices of the company.

On one day last week the Inspiration Consolidated mine produced 19,700 tons of ore in 24 hours. The Live Oak section is yielding high-grade silicious ore. Preparations are under way for construction of two more units at the mill. A Kansas City firm has the contract for steel erection.

At Globe the Old Dominion mine is producing 1200 tons of ore daily. The smelter is treating a good deal of custom ore, including some from the United Verde Extension at Jerome.

MOHAVE COUNTY

(Special Correspondence.)—Announcement has been made that Oatman is to have a custom mill. Mr. Brush, superintendent of the Gold Dust, is now in Los Angeles perfecting arrangements for the resumption of milling at this property, and it is stated that the company would employ some of its stamps on custom ore. The mill is completed, and only needs a few repairs to allow starting within 30 days. The pumping plant of the Gold Dust company will also be started if present plans materialize to bring the water from the Colorado river to the property for milling and domestic purposes.

During the past week the Big Jim mine had a visitors' day, being thrown open for inspection by the public. This property is a mine. The developments are everything that was claimed for them, particularly on the 400 and 485-ft. levels. Assays were taken right across the face of the drift at 400 ft. and gave \$658 and \$333 per ton. The superintendent, Mr. Keating, said that this orebody would average around \$400. Oatman, July 5.

For the first time since last October 20 stamps are being operated in the mill of the Tom Reed company, instead of ten.

PINAL COUNTY

In hole No. 43, 200 ft. north of No. 21, the Ray Hercules company at Ray has cut 51 ft. of 1.5% copper ore. The ore is extending north instead of to the fault. It has been definitely decided to erect a 1000-ton mill, employing flotation.

YAVAPAI COUNTY (JEROME)

The Hull and Cleopatra properties have been acquired by the United Verde Copper Co. for a large sum. The company is to increase its mine and smelter force considerably.

At 1400 ft. in the United Verde Extension the orebody has been developed by 2000 ft. of lateral work and two raises up 100 ft. A winze is being sunk 200 ft. below the level. There is blocked out 600,000 tons of 16% ore. A new two-compartment shaft for hoisting ore only, is to be sunk. The company is shipping to smelters in Arizona, at a considerable distance from Jerome, over 7000 tons of ore per month, averaging 20% copper, resulting in net profits of about \$350,000 for several months past. These earnings are due in part to the prevailing high prices for copper. Cash on hand is \$793,882; there is due from ore shipped approximately \$1,000,000, making a total of \$1,793,882.

CALIFORNIA

AMADOR COUNTY

Mining of chrome ore in the vicinity of Ione is increasing in

importance. The Julia Barilli mine is to commence shipping at an early date.

A 10-stamp mill, formerly working at the Chimax mine near Pine Grove, is being re-erected at the Pitts mine of M. Robinson in the same district.

ELDORADO COUNTY

According to Burr Evans there are over 100 miles of buried river channels, containing gold-bearing gravel, in this county. They lie at a depth of a few feet to 300 ft. below the surface. One is known as the 'Blue Lead,' the other the 'Red' or 'Grey Lead.' The deposits are from 2 to 30 ft. thick, with a grade of \$2 to \$5 per ton of gravel.

NEVADA COUNTY

It is now fairly certain that the Murchie mine near Nevada City is to be re-opened. Prior to closing 75 men were employed.—The Sultana mine, closed for two years, is now employing 15 men, in charge of A. W. Crase.

On July 4 a first-aid contest was held at Grass Valley, resulting in the North Star winning with 95.5%, followed closely by the Empire team.

SHASTA COUNTY

County assessments for this year will be \$2,000,000 greater than they were in 1915. Nearly all classes of property had increases, including \$250,000 extra on the Mammoth Copper Co.'s holdings, \$40,000 on the Mountain Copper, and \$25,000 on the Balaklala.

SIERRA COUNTY

The Alleghany district, according to the Nevada City News, is more active than for many years. During 1915 fresh capital became available for mines. The Plumbago mine is to add 5 stamps to its present 15 head, making a daily capacity of up to 70 tons.—At the Morning Glory, adjoining the Tightner, a compressor, hoist, and 5-stamp mill are to be erected.—The Sixteen to One owners are installing a 75-hp. hoist, and are considering a mill.—Joshua Hendy of San Francisco is to supply a 50-ton plant for the Twenty-One, in addition to the Lane mill now working.—An Allis-Chalmers ball-mill is in course of erection at the Irelan mine.—A compressor has been ordered for the Louise Consolidated, in charge of C. O. Jackson.—These extensions of plant will raise the daily capacity 100 tons, making a total of 350 to 400 tons, employing 300 men in mines and plants.—Results at the rich Tightner mine continue satisfactory.

The Forest City district is also to have a good year, judging by proposed work and prospects of the North Fork, Wisconsin, South Fork, Young America, Cincinnati, York-Finney, and other gravel and quartz properties.

Electric power is available throughout these districts; roads are good, labor is satisfactory, wood is abundant, and mails are regular.

TRINITY COUNTY

A 5-cu. ft. dredge, composed of parts from an old boat, is to be constructed on the Paulsen ranch, near Lewiston, by the Trinity Star Dredging Co. Fred Paulsen is a director of this concern, which includes W. F. Davis, S. Keeler, and W. B. Winston of San Francisco.

TUOLUMNE COUNTY

For the Dutch-App mines a large hoist has been ordered. An option has been secured on the J. App ranch, west of the App mine, for dumping purposes.

COLORADO

LAKE COUNTY (LEADVILLE)

Drainage of the Harvard shaft and surrounding ground to a depth of 407 ft., by the U. S. S. R. & E. Co., is nearly completed. In 24 days there was 175,000,000 gal. of water removed. A month will be required to clean-up the debris, lay

track, and cut a pump-station. Sinking 300 ft. deeper will then be started. Prescott steam sinking-pumps are to be used.

TELLER COUNTY (CRIPPLE CREEK)

(Special Correspondence).—Gold production for June, as reported by the mills and smelters, is as follows:

	Tons	Value	Gross value
Golden Cycle, Colorado City	39,000	\$17.00	\$663,000
Portland, Colorado Springs	10,000	20.00	200,000
Portland, Victor mill	18,750	2.58	48,375
Portland, Independence mill	9,696	2.16	20,943
Smelters, Denver and Pueblo	4,500	55.00	247,500
Reid-Gold Sovereign mill	700	3.25	2,275
Worcester-Rubie mill	300	4.26	1,275
Total	82,946	\$14.26	\$1,183,268

The Golden Cycle Mining & Reduction Co. paid its regular monthly dividend at the rate of 2c. per share, or \$30,000, on July 10. This makes a total of \$210,000 for the present year.

On July 25 the Vindicator Consolidated distributes \$90,000. Cripple Creek, July 1.

IDAHO

The State mine inspector, Robert N. Bell, has the following to say about the Wood River region:

"This area is also experiencing a revival of mining interest. The recent transfer of the North Star mine to the Federal Mining & Smelting Co. is an indication of vital importance to the continued progress of the mining industry of the State at this time, from the fact that the orebody of the North Star mine presents what is probably one of the most refractory combinations of mineral elements ever discovered. Its valuable metal contents are silver, lead, and zinc; but these, in important average value, are locked up with a combination of sulphur, arsenic, iron, and antimony in such a manner as to have resisted all previous efforts for their successful separation. The recent development in hydro-electric metallurgical science, which insures the successful and profitable treatment of these refractory minerals, about marks the limit in ore-treatment progress, and presents a wide field for its further application to Idaho mineral resources. Some most encouraging results of rich ore disclosures by deep development have recently been encountered in the Wood River district, and a decided revival is manifested in that region, which contains a wide distribution of promising ore prospects in great variety."

BOISE COUNTY

Operations at some of the mines in this county are briefly as follows:

The National Mining & Development Co. at Placerville, A. C. Gallup, manager, has a 10-stamp mill, employing amalgamation, concentration, and cyanidation.—The Golden Age Jr. Mining Co. at Pioneerville, T. H. Sedina, manager, has a mill treating ore by amalgamation and concentration.—The Diana Mines Co. is developing lead-copper properties.—The Washington, Sub Rosa, and Gold Coin properties, near Idaho City, were recently consolidated and taken over by Oklahoma people. Development was started on June 1. F. E. Johnesse is in charge.—The Lucky Boy at Idaho City is developing its mine and enlarging the mill, also installing power-plant. F. E. Johnesse is manager.

At the Nellie mine, Horseshoe Bend, 16 stamps are crushing, followed by amalgamation and concentration. M. E. Hopkins is manager.—Several properties at Pearl are being re-opened but there is no production at present.

BOUNDARY COUNTY

The Idaho-Continental mine, 26 miles from Porthill, has 50 men repairing the road. The new 300-ton mill is expected to be producing 60% lead and 30-oz. silver concentrate by August 1.

SHOSHONE COUNTY (COEUR D'ALENE)

Development of the Chicago-Boston Mining Co.'s property in Lake gulch, 1½ miles west of Wallace, has been so good that a 200-ton mill is contemplated.

During the first quarter of 1916, the Federal Mining & Smelting Co.'s profit from 31,844 tons of ore and concentrate shipped was \$290,890.

MICHIGAN

THE COPPER COUNTRY (HOUGHTON, ETC.)

(Special Correspondence).—The most encouraging feature about the Ahmeek mine is the increased amount of copper in the ore that comes from this northern end of the mine. This was not expected. Two stamps are crushing ore.

When the Calumet & Hecla took over the Isle Royale along with the other Bigelow properties, the officials looked on the former as questionable. Lower openings did not look encouraging, operations were conducted at an actual loss, and copper was none too high in price. Now earnings are at the rate of \$1,000,000 per month; the second dividend in 50 years has been paid, and the mine is opening well.

No work has as yet been done to re-build the Trimountain stamp-mill, as the mines' output of Trimountain, Champion, Baltic, and Lake is cared-for in the Baltic and Champion mills, which are at present saving a greater percentage of copper than expected. The re-grinding plant is working satisfactorily. The burned Trimountain mill is being cut-up and sold at better prices than expected, as a good deal of the steel is fit for use in other construction work.

It is probable that the Centennial will pay a dividend. Richer ore is being developed. The treasury is accumulating a large surplus.

Houghton, June 27.

MISSOURI

JASPER COUNTY (JOPLIN)

Zinc-ore prices were weaker last week, easing off to \$85 per ton for 60% product. The output of the Missouri-Kansas-Oklahoma district was 6290 tons of blende, 32 tons of calamine, and 937 tons of lead, averaging \$68, \$50, and \$75 per ton, respectively. The total value was \$511,915.

MONTANA

MINERAL COUNTY

The east Coeur d'Alene district in western Montana, around Salt Lake, is more active than for several years. Good developments are reported from the Last Chance, Monitor, Silver Cable, and Tarbox. A mill is planned for the Silver Cable zinc ore.

SILVERBOW COUNTY (BUTTE)

To improve ventilation on the lower levels the Tuolumne company is raising from 2600 to 2400 ft. A winze will then be sunk from 2600 ft. Daily shipments are 50 tons. The company is re-tilt-boring 700 ft. of the Butte-Main Range shaft.

NEVADA

ESMERALDA COUNTY (GOLDFIELD)

Final figures of the Goldfield Consolidated's May output give a profit of \$50,693 from 32,400 tons. Development covered 2658 ft. at a cost of \$5.59 per foot. This revealed little of importance. Net costs were \$4.66 per ton.

The estimated production of the Goldfield Consolidated company for June is as follows:

Ore mined, tons	29,000
Gross extraction	\$185,000
Operating expenses	145,000
Net realization	\$ 40,000

Interesting developments are expected at 1750 ft. in the Atlanta during the next 30 days. Drifts and raises between

the 1400 and 1750-ft. levels show large quantities of low-grade gold-copper ore that will be treated by flotation later on. Work at 890 ft. in the Jumbo Junior is also at an interesting stage, and at 1260 ft. in the Merger.

LINCOLN COUNTY

With a capital of \$10,000 the Consolidated Mining & Smelting Co. has been formed to operate in the Freiburg district, near Pioche. W. L. Leland of San Francisco is one of the largest shareholders.

NYE COUNTY

In the Jim Butler v. West End suit at Tonopah, the Supreme Court of Nevada on July 3 upheld the decision of the lower court, which was in favor of the West End. The original case concerned ore alleged to have been wrongfully extracted by the defendant. The recent judgment will be discussed in an early issue of this journal.

A report has been made on the property of the Kansas City-Nevada Consolidated Co. at Bruner by A. E. Swain of Kansas City, Missouri. The altitude is 6400 ft., and nearest railroad station is Luning, 55 miles west of Bruner. Fair wagon-roads connect. in the Paymaster claims 2585 ft. of work has been done. The vein is a fissure along a contact of andesite dike and rhyolite. The net value of reserves is \$85,162, after paying for mining and treatment of the gold ore. The Big Henry claims are of promise. Not enough work has been done in the Silent Friend claims to determine anything. The Duluth group indicates that considerable ore will be available. There is plenty of water for all purposes. A 50-ton plant, including a ball-mill, crusher, copper-plates, classifier, retort, etc., also pipe-line and other equipment is contemplated, costing \$75,000.

NEW MEXICO

SOCORRO COUNTY

(Special Correspondence).—The Mogollon Mines Co.'s clean-up for the last two weeks produced 14 bars of gold and silver bullion and 8 tons of high-grade concentrate. Ore treated in the past week was \$75 tons. The new 3-compartment shaft is now 40 ft. below the 700-ft. level and is being sunk at the rate of 2 ft. per day; it is in commission for regular hoisting from the 500-ft. level. This property is under the management of S. J. Kidder.

The Socorro Mining & Milling Co. is constructing a conveyor to dispose of tailing by elevating and fluming onto a comparatively flat area near the mill, to avoid discharging into the creek, which has caused more or less inconvenience to ranchers in the lower valleys in past years. The plant treats 230 tons of ore daily.

Surveys and measurements by Earl C. Cleaveland during the past two years on West Fork creek have demonstrated the availability of a minimum of 1000 to 1500 hp. during the dry seasons. For its magnitude this is probably the most feasible of the unappropriated water-rights within a radius of 35 miles, and if developed will supply the greater part of local power requirements. The mines for a number of years have used crude oil, freighted about 90 miles by wagon, as a source of power, at a cost of around \$150 per hp.-year. The rising price of crude oil is turning the companies' attention to the possibilities of water-power development, which will generate current at a fraction of the present cost by internal-combustion engines. It is understood the operators will contract for power at \$100 per hp.-year with any outside interests undertaking the installation.

Mogollon, June 27.

OREGON

BAKER COUNTY

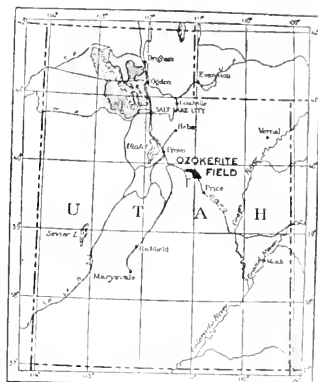
The E. & E. mine at Bourne is to be examined by C. O. Lindburg for the American Zinc, Lead & Smelting Co., which holds an option on it. The property has produced gold, but was closed since the early 90's.

UTAH

Transactions on the Salt Lake exchange during the first half of 1916 totaled 24,989,039 shares, valued at \$5,293,050, against 16,867,514 shares and \$3,968,516 in the whole of 1915, and 957,064 shares and \$1,663,955 in the same period of 1915.

In Bulletin 641-A of the U. S. Geological Survey, Heath M. Robinson discusses the ozokerite (mineral wax) deposits in central Utah (Utah and Wasatch counties). This mineral was also described in this journal of June 17, by L. O. Howard. The quantity of ozokerite available for future mining in the Utah field can hardly be estimated. The length and thickness of the fissured and fractured zones containing ozokerite are variable, even within short distances, and for areas beyond the limits of prospected ground no quantitative estimate can be made with safety. Many of the prospects and mines, however, showed ozokerite in place, and the fact that it is irregularly distributed should encourage more thorough prospecting. The price is now up to 40c. per pound.

The Wasatch Ozokerite Co.'s new mill at Soldier Summit is



MAP OF UTAH SHOWING THE OZOKERITE FIELD.

now operating satisfactorily, according to A. G. Burritt, a local engineer who recently visited the property. The company is making mineral wax.

JACOB COUNTY

The Eagle & Blue Bell mine, now producing only 50 tons of ore daily on account of congestion at smelters, is to sink its shaft from 1700 to 1850 ft.—The Colorado Consolidated shaft is down 1300 ft., the rate being 5 ft. daily.—A two-compartment shaft is to be sunk at Homansville or East Tintic by the Chief Consolidated company.

The Dragon Consolidated is shipping 400 tons of iron ore per day, divided among the A. S. & R., I. S., and U. S. S. R. & M. companies' smelters in Utah.

SALT LAKE COUNTY

In the American Fork district the Pacific company is to erect a 60-ton mill. Mr. Doeltle is manager.

At the Utah Metal & Tunnel Co.'s property at Bingham there are 7 sets of leases working in 7 old adits. The company's profit during the first half of 1916 was over \$600,000 copper. Ore is being milled and shipped to smelters, while lead ore is also shipped.

SUMMIT COUNTY (PARK CITY)

June shipments from all mines totaled 5589 tons, and 14,322 tons for 6 months.

Dividends paid on July 1 were \$187,500 by the Silver King Coalition, \$120,000 by the Judice Mining & Smelting, and \$63,750 by the Silver King Consolidated, a total of \$371,250.

WASHINGTON

OKANOGAN COUNTY

The new manganese mine near Omak has been leased by the Millroy company of Tacoma. One shipment contained 20% metal.

STEVENS COUNTY

At a depth of 242 ft. below the outcrop, No. 2 'chimney' has been cut in the Electric Point mine near Northport. For 18 ft. the galena averaged 75% lead, also mixed carbonate and crystals with 50% lead. Silver is over 20 oz. per ton. The remarkable feature of the development is the presence of so much crystallized lead in the carbonate ore of No. 2 chimney as to raise the grade from an average of 22% in the first chimney to 50% in the newly opened orebody. Galena is being shipped to Trail.

The old Germania tungsten mine near Springdale has been sold to German interests, with W. Von Scheek to be manager. Development has cost \$500,000, including the 200-ton mill, etc., which was dismantled recently. Litigation closed the property, and it never produced.

An effort is being made to revive the old Spokane Belle silver mine, 35 miles north of Spokane, near Clayton, one of the oldest mineral locations in this part. E. H. Belden, of Spokane, sole owner of the property, is arranging to form a syndicate to finance further development.

CANADA

BRITISH COLUMBIA

Net earnings of the Galena Farm Mining Co., near Silverton, were \$40,000 in May. From the 100-ton mill shipments aggregated 759 tons of concentrate that averaged 46.5% zinc and 20 oz. silver, which netted \$25 per ton, and 237 tons of concentrates averaging 67.3% lead and 66.1 oz. silver, netting \$125 per ton.

During 158 days in 1915 the British Columbia Copper Co.'s smelter at Greenwood treated 122,514 tons of ore. The Mother Lode mine contributed 105,085 tons, averaging 0.8746% copper, 0.037 oz. gold, and 0.21 oz. silver. The sulphur content was 3.15%. The metal output was 1,734,385 lb. of copper, 23,003 oz. of silver, and 5417 oz. of gold.

The new sulphuric-acid plant of the Consolidated Mining & Smelting Co. at Trail, which will produce acid as a by-product from smelter fume, the first plant of the kind to be erected in British Columbia, is in operation. The present daily output is 10 tons.

ONTARIO (COBALT)

The Buffalo company is to treat its own concentrate instead of shipping this product. A roasting-furnace and dust-chamber will be erected. The concentrate, 30 tons daily, is to be given a chloridizing roast. A large saving in freight and treatment charges will follow this installation. During its financial year ended April 30, 1916, the Buffalo Mines Co. produced 37,152 tons of ore, yielding 705,055 oz. of silver by all processes. The revenue was \$524,973, and operating expenses \$266,206. Reserves of ore in the mine and on dumps amount to 18,000 tons, averaging 18 oz. per ton. There is awaiting treatment 300,000 tons of tailing containing 1,600,000 ounces.

At Cobalt the Nipissing refinery was recently damaged by fire. The machinery was not badly damaged. On June 17 cash in bank amounted to \$965,534; bullion in transit, \$552,352; and ore and bullion on hand at the mine, \$330,026; a total of \$1,858,912. A dividend of 5% is payable on July 20.

KOREA

Details of the Oriental Consolidated company's April results are just to hand. The plants treated 25,142 tons for bullion valued at \$143,701. The Taracol and Maibong mills recovered 93.6% and 92.4% respectively. Tree planting for the season is over, the work including 175,000 acacias, larch, and pines.

PERSONAL

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

NEWTON B. KNOX was at Denver last week.

F. W. BRADLEY was at Kellogg, Idaho, this week.

G. G. S. LINDSEY has returned to Toronto from China.

WILLIAM W. MEIN is expected shortly in San Francisco.

EDWARD H. BENJAMIN is president of the Bohemian Club. HOWARD W. MOORE is engineer to the Calaveras Copper Co., at Copperopolis.

F. L. SIZER is making an inspection of mines in the Chloride district, Arizona.

BEN. B. LAWRENCE, who was in Oregon last week, is expected in San Francisco.

NELSON DICKERMAN is in New Mexico, but will be in San Francisco at the end of July.

J. A. L. HENDERSON, from London, passed through San Francisco on his way to Los Angeles.

OTTO SUSSMAN of New York was recently at Wallace, Idaho, inspecting the Interstate-Callahan mine.

HARRY HEINE and G. L. CLARK are at the Porcupine Vipond mine, and H. H. LAVERY is at the Dome.

R. W. SCHULTZ, formerly with the Mond Nickel Co., has joined the staff of Minerals Separation, Ltd.

HERBERT W. GEPP, of Broken Hill, Australia, is visiting the Bully Hill smelter, Shasta county, California.

ROSS K. MACARTNEY has been appointed manager for the Rhodesia Broken Hill company, South Africa.

G. A. DENNY is acting as technical advisor to the General Mining & Finance Corporation at Johannesburg.

PERRY MARSHMAN, manager of the Swansea Vale zinc plant, in South Wales, is visiting zinc smelters in this country.

T. LOUIS WELF has been appointed superintendent for the Gold Reed Mining & Milling Co., at Oatman, Arizona.

FRANK MERRICKS has been elected president of the Mining & Metallurgical Club (London). BEDFORD MCNEILL is vice-president.

J. B. TYRRELL, of Toronto, is spending some time in British Columbia. His address while there is the Vancouver hotel, Vancouver.

W. A. PAINE, president of the Copper Range Consolidated, and his son, F. WARD PAINE, are visiting in the Michigan Copper Country.

CLYDE T. GRISWOLD is heading the Associated Geological Engineers' field parties for extensive examinations in southwestern Oklahoma.

ROBERT MARSH, JR., general mine superintendent for the Nevada Consolidated Copper Co., is in military training camp at Monterey, California.

T. H. GILL, of the North Star company's Champion mine at Nevada City, has temporarily joined the staff of the California Accident Commission.

GILBERT RIGG, formerly with the New Jersey Zinc Co., has been appointed consulting metallurgist in zinc smelting to the Broken Hill Associated Smelters, in Australia.

JOSEPH H. WHITE, sanitary engineer for the U. S. Bureau of Mines, has resigned to take a similar position, including welfare work, with the Braden Copper Co. in Chile.

JOHN D. RYAN, president of the Anaconda Copper Mining Co., has been taking a holiday with his family at their old home in the Michigan Copper Country. He is now in San Francisco.

JAMES E. DAVIS, formerly superintendent of the Central Eureka mine at Sutter Creek, has been appointed superintendent for the Calaveras Consolidated Mining Co., at Melones, California.

THE METAL MARKET

METAL PRICES

San Francisco, July 11.

Antimony, cents per pound	15
Electrolytic copper, cents per pound	28.50
Pig lead, cents per pound	7.99-7.75
Platinum: soft metal, per ounce	\$79
Platinum: hard metal, 10% iridium, per ounce	\$74
Quicksilver: per flask of 75 lb.	\$83
Spelter, cents per pound	15
Tin, cents per pound	43
Zinc-dust, cents per pound	29

ORE PRICES

San Francisco, July 11.

Antimony: 50% product, per unit (1% or 20 lb.)	\$1.00
Chromite: 40% and over, f.o.b. cars California, per ton	12.00-14.00
Manganese: 50% product, f.o.b. cars California, ton	12.00-20.00
Magnetite: crude, per ton	5.99-10.00
Molybdenum: 50% and over, per pound	0.60-1.15
Tungsten: 60% WO ₃ per unit	25.00-35.00

Potash bulletin of the U. S. Geological Survey is now available. It contains 38 pages of useful information.

Recent tungsten (wolframite) concentrates from the Wasp No. 2 mine, South Dakota, were settled at the following rates.

Date	% WO ₃	Price per unit	Price per ton
June 1915	48.24	\$7.99	\$281.09
August	47.20	10.59	285.60
October	44.93	27.50	2,748.94
December	48.08	51.54	1,235.57
March 1916	62.02	82.00	5,085.64
"	35.34	82.00	2,897.88

In 11 lots of 208 tons the value was \$243,875.

EASTERN METAL MARKET

(By wire from New York.)

July 11.—Copper is neglected and prices are nominal; lead is quiet with re-sellers cutting prices; spelter is also neglected, but the bottom is near.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
July 6	63.37
" 7	62.75
" 8	62.00
" 9 Sunday	60.90
" 10	62.00
" 11	62.00

Monthly averages

1914.			1915.			1916.			Averages								
1914.			1915.			1916.			1914.			1915.			1916.		
Jan.	.....	57.58	48.85	.....	56.76	.....	54.90	.....	47.52	.....	.....	.....	.....	.....	.....	.....
Feb.	.....	57.53	48.45	.....	56.74	.....	54.35	.....	47.11	.....	.....	.....	.....	.....	.....	.....
Mch.	.....	58.01	50.61	.....	57.89	.....	53.75	.....	48.77	.....	.....	.....	.....	.....	.....	.....
Apr.	.....	58.52	50.25	.....	64.37	.....	51.12	.....	49.10	.....	.....	.....	.....	.....	.....	.....
May	.....	58.21	49.87	.....	74.27	.....	49.12	.....	51.88	.....	.....	.....	.....	.....	.....	.....
June	.....	56.43	49.03	.....	65.94	.....	49.27	.....	55.34	.....	.....	.....	.....	.....	.....	.....

The past week's quotations indicate sudden fluctuations, probably due to speculation. On page 97 of this issue are some interesting notes on silver, rather 'bullish' in tone.

Exports of silver from San Francisco during the first half of 1916 amounted to \$241,388 as coin and \$4,209,105 as bullion.

The West End Consolidated at Tonopah is paying 100¢ per share.

TIN

Prices in New York, in cents per pound.

Monthly averages							
	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	
Feb.	39.76	37.23	42.60	Aug.	30.20	34.27	
Mch.	38.10	48.76	50.50	Sept.	33.10	33.32	
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00	
May	33.29	39.28	49.10	Nov.	33.51	39.50	
June	39.72	40.26	42.97	Dec.	33.60	38.71	

Tin is easy at 38.87 cents.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the

open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
June 13	June 27
" 20	July 4
" 27	July 11
" 34	July 18
" 41	July 25
" 48	August 1
" 55	August 8
" 62	August 15
" 69	August 22
" 76	August 29
" 83	September 5
" 90	September 12
" 97	September 19
" 104	September 26
" 111	October 3
" 118	October 10
" 125	October 17
" 132	October 24
" 139	October 31
" 146	November 7
" 153	November 14
" 160	November 21
" 167	November 28
" 174	December 5
" 181	December 12
" 188	December 19
" 195	December 26
" 202	January 2
" 209	January 9
" 216	January 16
" 223	January 23
" 230	January 30
" 237	February 6
" 244	February 13
" 251	February 20
" 258	February 27
" 265	March 6
" 272	March 13
" 279	March 20
" 286	March 27
" 293	April 3
" 300	April 10
" 307	April 17
" 314	April 24
" 321	April 30
" 328	May 7
" 335	May 14
" 342	May 21
" 349	May 28
" 356	June 4
" 363	June 11
" 370	June 18
" 377	June 25
" 384	July 2
" 391	July 9
" 398	July 16
" 405	July 23
" 412	July 30
" 419	August 6
" 426	August 13
" 433	August 20
" 440	August 27
" 447	September 3
" 454	September 10
" 461	September 17
" 468	September 24
" 475	September 30
" 482	October 7
" 489	October 14
" 496	October 21
" 503	October 28
" 510	November 4
" 517	November 11
" 524	November 18
" 531	November 25
" 538	December 2
" 545	December 9
" 552	December 16
" 559	December 23
" 566	December 30
" 573	January 6
" 580	January 13
" 587	January 20
" 594	January 27
" 601	February 3
" 608	February 10
" 615	February 17
" 622	February 24
" 629	March 2
" 636	March 9
" 643	March 16
" 650	March 23
" 657	March 30
" 664	April 6
" 671	April 13
" 678	April 20
" 685	April 27
" 692	May 4
" 699	May 11
" 706	May 18
" 713	May 25
" 720	June 1
" 727	June 8
" 734	June 15
" 741	June 22
" 748	June 29
" 755	July 6
" 762	July 13
" 769	July 20
" 776	July 27
" 783	August 3
" 790	August 10
" 797	August 17
" 804	August 24
" 811	August 31
" 818	September 7
" 825	September 14
" 832	September 21
" 839	September 28
" 846	October 5
" 853	October 12
" 860	October 19
" 867	October 26
" 874	November 2
" 881	November 9
" 888	November 16
" 895	November 23
" 902	November 30
" 909	December 7
" 916	December 14
" 923	December 21
" 930	December 28
" 937	January 4
" 944	January 11
" 951	January 18
" 958	January 25
" 965	February 1
" 972	February 8
" 979	February 15
" 986	February 22
" 993	February 29
" 1000	March 6
" 1007	March 13
" 1014	March 20
" 1021	March 27
" 1028	April 3
" 1035	April 10
" 1042	April 17
" 1049	April 24
" 1056	April 30
" 1063	May 7
" 1070	May 14
" 1077	May 21
" 1084	May 28
" 1091	June 4
" 1098	June 11
" 1105	June 18
" 1112	June 25
" 1119	July 2
" 1126	July 9
" 1133	July 16
" 1140	July 23
" 1147	July 30
" 1154	August 6
" 1161	August 13
" 1168	August 20
" 1175	August 27
" 1182	September 3
" 1189	September 10
" 1196	September 17
" 1203	September 24
" 1210	September 30
" 1217	October 7
" 1224	October 14
" 1231	October 21
" 1238	October 28
" 1245	November 4
" 1252	November 11
" 1259	November 18
" 1266	November 25
" 1273	December 2
" 1280	December 9
" 1287	December 16
" 1294	December 23
" 1301	December 30
" 1308	January 6
" 1315	January 13
" 1322	January 20
" 1329	January 27
" 1336	February 3
" 1343	February 10
" 1350	February 17
" 1357	February 24
" 1364	March 2
" 1371	March 9
" 1378	March 16
" 1385	March 23
" 1392	March 30
" 1399	April 6
" 1406	April 13
" 1413	April 20
" 1420	April 27
" 1427	May 4
" 1434	May 11
" 1441	May 18
" 1448	May 25
" 1455	June 1
" 1462	June 8
" 1469	June 15
" 1476	June 22
" 1483	June 29
" 1490	July 6
" 1497	July 13
" 1504	July 20
" 1511	July 27
" 1518	August 3
" 1525	August 10
" 1532	August 17
" 1539	August 24
" 1546	August 31
" 1553	September 7
" 1560	September 14
" 1567	September 21
" 1574	September 28
" 1581	October 5
" 1588	October 12
" 1595	October 19
" 1602	October 26
" 1609	November 2
" 1616	November 9
" 1623	November 16
" 1630	November 23
" 1637	November 30
" 1644	December 7
" 1651	December 14
" 1658	December 21
" 1665	December 28
" 1672	January 4
" 1679	January 11
" 1686	January 18
" 1693	January 25
" 1700	February 1
" 1707	February 8
" 1714	February 15
" 1721	February 22
" 1728	February 29
" 1735	March 6
" 1742	March 13
" 1749	March 20
" 1756	March 27
" 1763	April 3
" 1770	April 10
" 1777	April 17
" 1784	April 24
" 1791	April 30
" 1798	May 7
" 1805	May 14
" 1812	May 21
" 1819	May 28
" 1826	June 4
" 1833	June 11
" 1840	June 18
" 1847	June 25
" 1854	July 2
" 1861	July 9
" 1868	July 16
" 1875	July 23
" 1882	July 30
" 1889	August 6
" 1896	August 13
" 1903	August 20
" 1910	August 27
" 1917	September 3
" 1924	September 10
" 1931	September 17
" 1938	September 24
" 1945	September 30
" 1952	October 7
" 1959	October 14
" 1966	October 21
" 1973	October 28
" 1980	November 4
" 1987	November 11
" 1994	November 18
" 2001	November 25
" 2008	December 2
" 2015	December 9
" 2022	December 16
" 2029	December 23
" 2036	December 30
" 2043	January 6
" 2050	January 13
" 2057	January 20
" 2064	January 27
" 2071	February 3
" 2078	February 10
" 2085	February 17
" 2092	February 24
" 2099	March 2
" 2106	March 9
" 2113	March 16
" 2120	March 23
" 2127	March 30
" 2134	April 6
" 2141	April 13
" 2148	April 20
" 2155	April 27
" 2162	May 4
" 2169	May 11
" 2176	May 18
" 2183	May 25
" 2190	June 1
" 2197	June 8
" 2204	June 15
" 2211	June 22
" 2218	June 29
" 2225	July 6
" 2232	July 13
" 2239	July 20
" 2246	July 27
" 2253	August 3
" 2260	August 10
" 2267	August 17
" 2274	August 24
" 2281	August 31
" 2288	September 7
" 2295	September 14
" 2302	September 21
" 2309	September 28
" 2316	October 5
" 2323	October 12
" 2330	October 19
" 2337	October 26
" 2344	November 2
" 2351	November 9
" 2358	November 16
" 2365	November 23
" 2372	November 30
" 2379	December 7
" 2386	December 14
" 2393	December 21
" 2400	December 28
" 2407	January 4
" 2414	January 11
" 2421	January 18
" 2428	January 25
" 2435	February 1
" 2442	February 8
" 2449	February 15
" 2456	February 22
" 2463	February 29
" 2470	March 6
" 2477	March 13
" 2484	March 20
" 2491	March 27
" 2498	April 3
" 2505	April 10
" 2512	April 17
" 2519	April 24
" 2526	April 30
" 2533	May 7
" 2540	May 14
" 2547	May 21
" 2554	May 28
" 2561	June 4
" 2568	June 11
" 2575	June 18
" 2582	June 25

Eastern Metal Market

New York, July 5.

All the metals are dull, and if quotations are not lower in each case, they at least are weak.

Copper prices are fairly well sustained, considering the stagnation of the market.

Zinc has continued to decline steadily.

Lead is irregular and quiet.

Tin is lower, and a dull month is predicted because of the large supply and heavy deliveries into consumption.

Antimony continues on the downward grade.

Aluminum is easier.

With the steel mills domestic business is lighter, as heretofore mentioned, but specifications on the books are enough to insure activity to the end of the year and therefore maintained prices, or at least, prevent substantial declines. Forgings for large shells constitute a large item with the larger mills. The total pig-iron production in June was 3,211,588 tons, or 107,053 tons per day, against 3,361,073 tons in May, or 108,422 tons daily. Furnaces are showing the effects of their forced operations. There is a heavy export demand for steel-making iron. Iron and steel exports in May totaled \$72,918,000, against \$26,536,000 in the same month of 1915. The total for 11 months ending May was \$545,418,000, compared with \$279,000,000 for the record period ending May, 1913.

Munitions' makers who have finished their contracts are beginning to offer their machine-tools on the open market, but not to a degree which injures the industry.

COPPER

In the past week the situation in copper has undergone little change, and interesting features are almost entirely lacking. There is little demand, in fact, representatives of the trade say they do not see how the market could be more dull. Despite the quiet, prices are fairly well maintained, a situation which is attributed to the sold-up condition of the larger producers. As a matter of fact near-by copper is not nearly so easy to obtain as some of the daily papers assert. The nominal quotation for prompt electrolytic is 26.50c., cash, New York, or about 26.37½c., 30 days, delivered, while Lake is nominally quoted at 27c., cash, for prompt. Just a trifle better tone is apparent, which is based on the present drive of the Allies against the Germans. It is argued that enormous quantities of ammunition are being used, and that a fresh demand for copper may be created. Exports in June reached the excellent total of 35,753 tons, a figure which has been exceeded in only one month since the beginning of the War. The London market is weak. On June 30, when the last cable quotation was received, electrolytic was quoted in London at £132.

ZINC

Quotations for this metal are weak the world over. In New York and at St. Louis prices have continued to decline, and to do so without exciting the interest of consumers. Today prompt zinc is easily obtainable at 11c., New York, and this price probably could be shaded. It is equivalent to 10.25c., St. Louis. July delivery can be had at 10.50c., St. Louis, and August at 10c. At London, July 3, the market dropped £10 to £51 for spot, and £8, to £45, for futures. It is difficult to tell just why the market continues to decline so steadily, although a good guess would be that new producers are eager to get business, while the old ones are determined to retain their hold on the field. Consequently there is no maintenance of prices, and the consumers, aware of the situation, can afford to stand by and see just how low prices will go. The market is being made by offerers. Exports last month totaled

4275 tons. The quotation for sheet zinc is 18c., f.o.b. smelter, carload lots.

LEAD

Reports of the actual condition in lead are contradictory, inasmuch as some sellers declare they are doing a fair business, while others say there is nothing doing. One thing is certain, and that is the recent decline in the market was checked by some export buying, including one lot of perhaps 5000 tons for Russia. Since then the New York quotation of independent sellers has been 6.85c., and that at St. Louis about 6.65c., although a good sale involving shipments covering the last half of the year was made at substantial concessions from these prices. The A. S. & R. Co. continues to quote 7c., New York, and 6.92½c., St. Louis. The London market is weak at a price equivalent to 6c., New York, and makes further export business improbable. Lower domestic prices are indicated. Exports in June totaled 2029 tons.

TIN

The market has continued dull, and prices are lower. Aside from these basic features, interest is centred in the June statistics. These showed that the arrivals of the month totaled 5695 tons, and that the deliveries amounted to 6398 tons, thereby demonstrating that consumption is heavy. Of the deliveries, 2198 tons came from the Pacific coast, a large part of which probably was Chinese tin. The heavy deliveries indicate a slow month for the brokers. The total of American deliveries in the past six months was 28,621 tons, which compares with 22,217 tons in the first half of 1915, an increase of 6404 tons. In stock and landing, June 30, was 3963 tons, against 2468 tons, May 31, an increase of 1495 tons. The London market is weak. The New York quotation was easy at 38.87½c., July 3, but despite this low price, business could not be done.

ANTIMONY

This metal is demoralized; the only question is where the decline in price will stop. It can be bought today at 16c., per lb. for spot, and 15c. for futures, and it is asserted that a firm offer considerably below these figures would not be spurned. Should there be an influx of shrapnel-shell orders, the market would take a sharp turn upward, but such orders are not considered probable.

ALUMINUM

The quotation for spot No. 1 virgin aluminum, 98 to 99% pure is lower at 60 to 62 cents.

ORES

Antimony: The quotation is unchanged and nominal at \$2 per unit.

Tungsten: In a general way the situation is unchanged and the quotation remains unchanged at \$30 to \$35 per unit. No business of importance has been done, although there are several live inquiries. Some of these come from sources new to the sellers. The Tungsten Products Co., Boulder, Colorado, has purchased a 5-ton Rennerfelt electric furnace, 150-kw. for making ferro-tungsten. One 3-ton electric furnace, and one 6-ton, have been purchased by other parties, also for the manufacture of ferro-tungsten.

Melting brass and bronze with the electric furnace is not new in Europe, but has not been done very successfully heretofore in the United States. Two Rennerfelt electric furnaces have just been sold by Hamilton & Hansell, New York, for melting these alloys. The Gerline Brass Foundry Co., Kalamazoo, Michigan, has bought a 3-ton furnace for bronze, and the Titanium Alloy Mfg. Co., Niagara Falls, New York, has bought a similar furnace, also for bronze.

COMPANY REPORTS

MIJNBOW MAATSCHAPPIJ REDJANG-LEBONG

This silver-gold producing company's property is in Sumatra, Dutch East Indies, a few hours from Singapore. The report of the general manager, F. C. Frey, is for the year 1915.

Development amounted to 1675 metres (5508 ft.). The ore-body was cut on No. 7 level of the middle shaft during May, but water makes further work slow. Possibilities of opening ore at depth are sufficiently encouraging to warrant sinking the shaft to No. 10 level; but with the electric power available this cannot be done yet. Drought interfered with operations last year. Two new power schemes have been investigated. Mine ventilation was improved. Old stopes were filled with 48,630 tons of waste. Ore reserves are estimated at 220,000 tons, assaying \$8 gold and 2 oz. 8 dwt. silver per ton. During

MT. LYEELL MINING & RAILWAY CO.

The report of Robert Sticht for the half-year ended March 31, 1916, states that the supply of labor for the mines was in sufficient; 1180 ft. of development was performed the Mt. Lyell pyritic orebody was opened for 50 ft. on No. 2 level averaging 10 ft. wide, which is considered to be a portion of the lowest extremity of the deposit, favorable results attended prospecting at 1200 ft. in the North Lyell mine; ore reserves in the Mt. Lyell mine are 1,815,505 tons assaying 0.53% copper, 1.96 oz. silver, and 0.04 oz. gold; in the North Lyell 1,110,341 tons of 0% copper, 1.33 oz. silver, and 0.005 oz. gold; in the South Lyell 464,352 tons of 0.4% copper, 0.2 oz. silver and 0.04 oz. gold; the flotation plant was started on February 17, and in 132 hours treated 1475 tons of Lyell Comstock ore of 3.25% grade for 444 tons of 8.83% concentrate, a satisfactory result the smelter reduced 170,992 tons of ore, (90,375 from the Mt. Lyell and 59,497 from the North Lyell), flue-dust, matte, slag etc.; converters produced 6,539,840 lb. of copper, 4682 oz. of gold, and 200,771 oz. of silver; the cost of producing blister-copper in Tasmania was \$4.56 per ton of ore; investigations were made on the recovery of sulphur from the blast-furnaces; and the hydro-electric power scheme gave complete satisfaction.

Owing to the good season throughout Australia the super-phosphoric works at Melbourne, Adelaide, and Fremantle produced a large quantity of fertilizer.

The revenue from metals, chemical products, and railroad traffic totaled \$426,693 (\$2,050,000). The 20th dividend absorbed \$80,575, making \$3,956,492 to date. Taxes amounted to \$65,951 (Federal, State, and War). The company has options on the Hercules, Tasmanian Copper, and Primrose mines on the west coast of Tasmania. These ores are complex, and are being tested by flotation at Broken Hill.

An average of 2.61 blast-furnaces was kept up. The coke works in New South Wales supplied the coke necessary. Rainfall at the mine was 35.67 inches on 112 days. Production to date is 142,676 tons of copper, 11,521,543 oz. of silver, and 341,079 oz. of gold.



MAP OF THE DUTCH EAST INDIES.

The Redjang Lebong mine is in Sumatra, which is also an oil producer. Banks and Billiton islands and the Malay Peninsula are large tin producers, also part of Sumatra has zinc-lead mines, also ruby deposits and oil. In Borneo are oil, dredging areas, and gold lodes. The Celebes have copper and gold mines. In the Philippines are well-known lode and dredging properties. New Guinea has mining possibilities.

the year 13,094 tons of \$9.50 gold and 2 oz. 17 dwt. silver were was recovered from old stopes. This was formerly regarded as unprofitable. The value of the ore gets less with depth.

There were 70 stamps operated 293 days, and 6 tube-mills 248 days, crushing 83,329 tons of ore. This averaged \$8.78 gold and 2 oz. 15 dwt. silver per ton. There was no amalgamation done. Pulp was classified into 67.5% for slime and 32.5% for sand treatment. The slime plant gave 94.83% gold and 84.59% silver recovery, and the sand plant 86.99% gold and 75.64% silver. Cyanide percolates with ease through sand averaging 80% passing 200-mesh. The total extraction of value was 90.69%. Metal recovery was 34,204 oz. of gold and 186,678 oz. of silver, worth 1,951,500 florins (1 florin = 40 cents). The cost was \$6 per ton. Dividends absorbed 431,250 florins or \$172,500. Employment was given to 45 Europeans and 1747 colored people.

Among the experiments done during the year were included how to economize in cyanide and zinc, also the local treatment of slag.

McINTYRE PORCUPINE MINES

The financial year of this Ontario company ended on March 31, 1916. The report of the manager, R. J. Ennis, contains interesting notes and three geologic plans. The property adjoins the Hollinger, Schumacher, and Plenaurnum mines, and includes most of Pearl lake.

Development amounted to 6584 ft., also 5787 ft. of diamond-drilling. Payable orebodies are not found in the quartz-porphry of No. 1 shaft. Those at No. 4 are confined to an area of two acres of basaltic-schist. Ore reserves are estimated at 201,920 tons, averaging \$11.12 gold per ton. Mining cost \$2.5116 per ton.

The mill treated 105,758 tons, assaying \$7.709 per ton, with 95.6% recovery, at a cost of 96.18c. per ton. The ball-mill is entirely satisfactory. The plant now has a capacity of 450 tons per day.

The year's revenue was \$775,821, of which \$327,524 was profit. All costs were \$4.2783 per ton. The balance at credit is \$383,050.

BOOK REVIEWS

MECHANICAL ENGINEER'S HAND BOOK. By Lionel S. Marks. P. 1836. Index. McGraw-Hill Book Co., New York. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, \$5.

This work has been adapted from Hütte, translated and revised by a large staff of specialists on various engineering subjects. Modifications from the original text have been made in order to adapt the subject matter to American use and conditions. It is, however, not merely a translation, as the greater part of the book, especially those portions dealing with engineering practice, is entirely new. Thirteen specialists prepared the text on the properties of engineering materials, while that on automobiles, aeronautics, illumination, patent law, cost-accounting, industrial buildings corrosion, air-conditioning, fire-protection, and prevention of accidents, has each been prepared by separate writers. Mr. Marks and his collaborators have done a splendid work in presenting this reference work for the benefit of the engineering profession.

MICROSCOPICAL DETERMINATION OF THE OPAQUE MINERALS. By Joseph Murdoch. P. 165. Ill., index. John Wiley & Sons, Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.

Three-quarters of this book consists of tables for the classification and identification of minerals, arranged with thumb indentations. The first quarter of the book treats of the history, development, and technique of the microscopical determination of minerals. In a preface, L. C. Gratton of Cambridge, Massachusetts, remarks: "This scheme for determination of opaque minerals does not require a specialized training for its intelligent use. Practically the only requirement is to follow the simple directions. The entire scheme may be mastered by anyone possessing common sense and a good eye." The problems that were solved in the Harvard laboratories by this method of investigation include: the relation of gold and silver in ores as affecting choice of treatment; the condition of fine metal lost in mill tailing and in slag; the effect of roasting and leaching of sulphide-bearing tailing; the character of furnace matte; geological problems involving metal in pulp from drill-holes.

THE ENGINEER IN WAR. By P. S. Bond. P. 176. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$1.50.

This book is a revision and amplification of a series of articles that appeared recently in the *Engineering Record*. It is addressed mainly to the civilian engineer who is desirous of learning at least a little concerning the part he may be called upon to play in time of war. Any attempt, however, to write a complete treatise on military engineering is expressly disclaimed. The first two chapters deal with the military policy of the United States and with the general duties of the military engineer. The various branches of military engineering are then discussed, emphasis being placed upon the fact that, whereas the civil engineer in general aims to build a permanent structure at the lowest possible cost, the military engineer must build, in the least possible time and at whatever cost may be necessary, a temporary structure that will be serviceable. A chapter is devoted to the mobilization of material resources along the lines of the industrial preparedness census now being taken. The final chapter contains suggestions regarding ways in which engineers and contractors may fit themselves for military service in time of need, suggestions that will be much heeded by many engineers.

MINING DECISIONS

MINING CONTRACT—ABANDONMENT

A mining contract obligated the option-holder to install certain machinery and carry on development work. Abandonment of work for a period of six months was to operate as a forfeiture. Held, in a suit to quiet title and forfeit contract, that the obligation to commence work began with the signing of the option, and not after the machinery was installed. Failure for more than a year to install the agreed machinery was sufficient grounds for forfeiture of the contract.

Barandun v. Barandun Mining & Milling Co. (California), 156 Pacific, 473. March 8, 1916.

OIL LANDS CLAIMED BY UNITED STATES—JURISDICTION

A Court of Equity has jurisdiction to grant an interlocutory injunction in a suit brought by the United States to enjoin the taking of petroleum from land which the Government claims to own, and which constitutes its chief value, particularly where the United States owns adjacent oil-lands which might be drained by the defendant's alleged illegal operations.

El Dora Oil Co. v. United States (California), 229 Federal, 946. December 4, 1915.

OIL TRESPASS—DAMAGES FOR CONVERSION

One who wilfully and intentionally takes ore, timber, or other property from the land of another must respond in damages for the full value of the property taken, at the time of the conversion, without any deduction for the labor bestowed or expense incurred in removing and preparing it for the market; but if he commits the wrongful act unintentionally, or by mistake, or in the honest belief that he is acting within his legal rights, the measure of liability is the value of the property taken, less what it costs to produce it. This rule applies to trespass on oil-lands, and additional damages may be allowed for the withholding of compensation to the rightful owner.

Bryson v. Crown Oil Co. (Indiana), 112 Northeastern, 1. March 31, 1916.

PETROLEUM WITHDRAWALS—EFFECT OF

The proviso of the act of June 25, 1910, saving from the force and effect of petroleum withdrawals the rights of bona-fide occupants or claimants of oil or gas-bearing lands who at that date were in the diligent prosecution of work leading to discovery of oil or gas, contemplates work of actual development with a view to discovery of oil or gas, and does not include efforts to secure capital to carry on work of development or to secure a purchaser to take over the property. An order of withdrawal has the same force and effect as an adverse claim asserted by any qualified person; and if a claim within a withdrawn area would have been subject to peaceable entry by an adverse claimant because of lack of diligence on the part of the prospector, it would be defeated by the order of withdrawal. Where an application for patent under the mining laws is based on a certain specified location, and proceedings by the government are instituted against the same, charging that some of the alleged locators are without interest, the applicant will not be heard, in the absence of publication and all other processes attendant upon an original application, to assert that in fact he bases his application on a different location of the same land.

Pacific Midway Oil Co. et al. (Land Department), 44 Land Decisions, 420. April 21, 1915.



EDITORIAL

T. A. RICKARD, *Editor*



IF prosperity be measured by the purchase of luxuries, then the importation of diamonds and other precious stones indicates it unmistakably. In the fiscal year ending June 30 the port of New York admitted \$44,887,826 worth of precious stones, as against \$14,760,847 in 1915 and \$33,183,735 in 1914.

IN our issue of July 8 we criticized the mid-year summary of mining progress issued by the Geological Survey as being too general in its statements. Since then we have received the résumé prepared by Mr. Charles G. Yale covering mining operations in California and take pleasure in acknowledging that it is an admirable précis of information prepared by a trained journalist. In reports of this kind it is necessary to give live details as well as embracing generalities. To do so effectively in a modicum of space requires something more than a bundle of statistics.

OUR friend the editor of the Canadian Mining Institute bulletin has the saving sense of humor that makes the wheels of life run sweetly. What he had to say, in the July issue, on "the delicate subject" discussed in our issue of July 1 is excellent. That "all the really important mining undertakings in the United States are directed by 'Canadian engineers'" is manifestly true because to the Canadian only the undertakings so directed are of real importance. Joking apart, it is remarkable what a splendid group of metallurgists has been given to this continent by McGill University.

WE find it necessary to refer again to the Canadian Mining Institute's July bulletin, because it contains an article by Mr. David H. Browne, or what he explains as the joint effort of himself and his friend Mr. Gilbert Rigg, who is now on his way to Australia, and therefore unable to disclaim the responsibility. It reads a good deal like our friend in New York, so we shall presume that he and Mr. Rigg are equally thoughtful and sympathetic. Truly, such a splendid lay sermon is not often to be found in a technical publication, and we thank the editor, Mr. H. Mortimer-Lamb, for it. Canada has indeed found herself in this war; she is no longer merely a population, colony, or dominion, but a Nation.

ZINC continues to cheapen. Undoubtedly the estimate of production published by the U. S. Geological Survey scared the market, for the decline in price followed immediately thereafter. The forecast of an output this year 130% higher than that of 1914 was enough to make the producers of spelter think furiously and dejectedly.

Even though this official estimate erred in exaggerating the probable production, it had the effect of a loud warning to the careless optimists in the metal market. If the Government forecast be discounted by 25%, there still remains more than enough zinc for any visible demand. The price has fallen to 9½ cents per pound, as compared with 17½ cents in January.

DISCUSSION this week starts with some interesting comment by Mr. Courtenay De Kalb on Mr. Probert's articles on "Superficial Indications of Copper." Mr. De Kalb dwells upon the part played by gases of magmatic origin in producing the alteration of mineralized rock. Mr. Thomas Marshall, now with the North Star Mines at Grass Valley, recounts his early acquaintance with the discoverer of cyanidation and gives several interesting notes concerning the first application of the process in California. Mr. Loring Hanson corroborates Mr. Berry's description of the earthquake in Nevada. Mr. Harold French writes as a mining engineer to suggest a new scheme of prospecting, giving details of the cost involved.

QUICKSILVER has been the sport of artificial conditions, as our readers are aware. On another page we publish a timely summary of this branch of the mining industry as issued by the U. S. Geological Survey. The supply of quicksilver in this country has been coming from a few mines; in California the New Idria has contributed 75 to 80% of the output during the last decade, and in Texas the Chisos mine, in the Terlingua district, is the only important producer. In California, the New Almaden and Guadalupe mines, which are contiguous, are important, and quite recently the Oceanic has come into prominence. In Nevada, the output comes from a number of small mines. A discovery of high-grade cinnabar ore has been made recently near Morton, in Washington.

REFERRING to the subject of a national engineer reserve, discussed under "Preparedness" in our issue of June 24, we are glad to state that the legislation authorizing the organization of an Engineer Reserve has been enacted by Congress and has become effective as from July 1, 1916. This Army Reorganization Act contains provisions for the formation of an Officers Reserve, including engineers. The War Department is issuing an invitation to the engineers of the country to apply for commissions in the Reserve Corps of Engineers in the several grades from Second Lieutenant to Major, and any of our readers desiring information concerning the

method of procedure required to secure a commission should apply to the secretary of their respective national engineering society.

SCHEELITE in gold ore may make the ore more valuable for the tungsten than for the gold. Hand-picking the scheelite and treatment of the ore for gold is the usual procedure, as noted by Mr. A. D. Cox in our issue of January 8 describing practice at the Union Hill mine, Grass Valley. Fine crushing would usually make it impossible to save both the gold and scheelite, as the latter is friable and makes a floury mess. In this issue we publish an article describing the method at gold-scheelite mines in the South Island of New Zealand. The ore is crushed to 30-mesh, after being hand-picked, and the coarse gold is saved on copper plates. The pulp is classified before going to Wilfley tables, where the scheelite is separated, the sand being cyanided. As much as 55% pyrite may accompany the 35% of scheelite and the 2½ oz. gold in the concentrate. Roasting of the concentrate follows, with magnetic separation.

THE notorious I. W. W. is making trouble at the iron mines of the Mesabi range in Minnesota. The initials 'I. W. W.' officially mean 'Industrial Workers of the World,' and unofficially 'I Won't Work.' In Minnesota, agitators from Chicago found support from only a small minority. Foiled in an attempt to call a strike, the disturbers threatened the life and property of the miners, forcing them to stop work. It is charged that they intimidated, through the wife or other women of a household, that the husband or brother would be killed, or that the dwelling would be burned, unless the men of the family stopped work. Rather than live in a state of terror, many families quietly left the district and found employment elsewhere. This constitutes neither a strike nor a lock-out; it is plain terrorism. As the *Iron River Reporter* exclaims, "Think of it! In these United States of America, where men claim the greatest freedom of any nation on earth, a few professional agitators may invade a peaceful community and drive workmen from their toil and homes." An interesting side-light was thrown on the Mesabi strike when a particular agitator from Chicago communicated to the mine-managers that if they wanted trouble stopped, they could "make arrangements" with him. Even this is nothing new. The worker has ever been the victim of irresponsible anarchists, for that describes the man that disregards all the laws governing an organized community.

FROM the lengthy report of the Zinc Corporation meeting appearing in the *Financial Times* we gather that a concerted attack has been made on the management of that important company's affairs by Messrs. F. A. Govett and H. C. Hoover. At the meeting Mr. Govett, as chairman, made a full and frank statement; indeed he is habitually outspoken and ready to take shareholders into his confidence, to a degree exposing him to the charge of egoism. But it is a good fault, partic-

ularly at a time when the difficulties due to the War have caused complications in the company's affairs and offered a chance for malicious innuendo. In his speech he disclosed the extraordinary diversity of the company's financial participations and promotions. Business of this kind cannot be conducted in public view; much of it must be kept secret from competitors; therefore, it is essential that those in control hold the complete confidence of the shareholders. If the latter are unwilling to place such confidence in their trustees, the business becomes impracticable. The necessary dealings and interplays of finance must be taken on good faith if anything effective is to be done. We do not know why Messrs. Govett and Hoover should not be supported in their management; it seems to us that the Zinc Corporation would have been on the scrap-heap long ago if these two capable men had not co-operated strenuously to re-organize and administer it during bad times. The intrusion of an old feud is deeply regrettable and can do no good to anyone. Leaving this unpleasant phase of the subject, we note Mr. Govett's tribute to Mr. W. M. Hughes, now Prime Minister of the Australian Commonwealth, who has shown a keen appreciation, so rare among British officials, of the importance of the mining industry and of the necessity for protecting the metal production of the Empire. Apparently the idea of a bounty or preferential tariff on zinc is being advocated by him as the only means of helping the Australian zinc mines against foreign competition. Already a Zinc Producers Association has been organized to facilitate the sale of the concentrate produced at Broken Hill and schemes to build smelters are being planned with the hope that the Imperial Government will grant a bounty ensuring the price of spelter being maintained at £23, or \$115 per long ton, equivalent to 5 cents per pound. There is talk of an electrolytic plant to be built in Tasmania, where cheap hydro-electric power is available. An experimental plant of this kind is being erected at Newcastle in behalf of the Zinc Corporation and the Burma Corporation, which are under the same control. Meanwhile, under the energetic leadership of Mr. W. S. Robinson, the Associated Smelters combination, which acquired the Broken Hill Proprietary's works at Port Pirie, is helping to take care of much of the lead concentrate that used to be treated in Europe. Efforts to sell zinc concentrate in the United States were checked, says Mr. Govett, by the under-selling between the various Australian mining companies, leading to a reduction in price that spoiled the business. It seems to us that the import duty and the cost of freight to this country would be enough to prevent the establishment of such a trade. To bring spelter to the United States is like carrying coal to Pennsylvania; any importation sufficient to affect the market for the domestic output would provoke the demand for a protective duty, in addition to the 10% now levied on the gross value. Evidently the future of the zinc industry at Broken Hill is not yet assured and unless artificial support is forthcoming, by tariff legislation, it is likely that hard times will ensue when War prices cease to be paid for spelter.

Another Apex Decision

On July 3 the Supreme Court of Nevada affirmed the decision of the lower court in the *Jim Butler v. West End* case. Our readers will recall that in this dispute between two mining companies at Tonopah, the trial court had decided in favor of the West End Consolidated Mining Company, as recorded in our issue of May 15, 1915, at which time we published some details of the geologic structure on which the conflict was based. We confess that the opinion of the higher court, just as much as that of the lower one, in so far as either defines and discusses the geologic features, is unconvincing. The accompanying sketch is taken from the text of the decision. Two veins meet at *B*, the north-dipping vein appears to extend upward to *A*, where it reaches the top of the trachyte, which is there covered by a later flow of

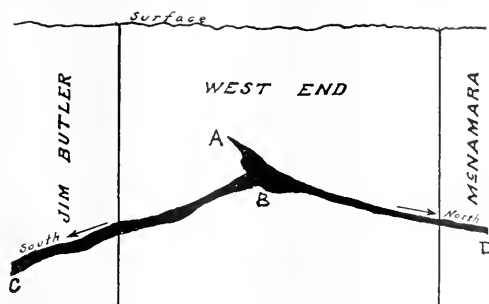


DIAGRAM OF VEIN STRUCTURE.

andesite. In short, the point *A* marks a former surface, at which the vein is cut off. The West End claimed this as an apex that gave it the right to follow not only the north-dipping vein but also the one dipping south into the Jim Butler ground. The principal feature of the case was the introduction of a theory that the two limbs of this structure constituted an antinormal arch. In the opinion of the Supreme Court the second of the two main questions of law submitted to it—the first dealing with irregularity of end lines—was “whether, within the meaning of the Act of Congress, the crest or crown of a vein which is found in the form of a single anticline may be regarded as the top or apex of the vein, and extra-lateral rights exist upon such vein in opposite directions.” The Court decides that “if it be true that the law contemplates that every vein has an apex, then it necessarily follows, we think, that the crest of the antinormal roll is the apex.” The lower court evidently was puzzled by a set of conditions so far outside the knowledge of the original framers of the law of 1872, and Judge Averill’s opinion reflected his perplexity, for he did not accept the idea of a ‘blanket’ or ‘contact’ vein, while talking about “the antinormal axis of the united main quartz bodies.” No wonder that he confessed that “the condition described is one that escaped the foresight of Congress and is also exceedingly remote from the simplicity of the plan they chose to adopt; yet the

law must be applied to it.” And the law is going to have a hard time in cracking this nut. The Supreme Court of Nevada has faced the chief problem, whether extra-lateral rights exist upon a vein in the form of a single antinormal fold and whether those rights extend over both limbs of the structure or only over the one having the same dip as the discovery vein. It decides in favor of both directions, declining to hold that “end lines may be considered as having only one direction.” Therefore there is “nothing in the statute which militates against extra-lateral rights upon such vein in opposite directions the same as though it were two veins with separate apices, instead of one vein.” A lot of space in the opinion is given to defining ‘top’ or ‘apex,’ but there is no definition of ‘antinormal fold.’ Is any continuous deposition of ore along a contact or along two contacts that intersect to be considered an antinormal if it has the shape of a fork, pent-house, or arch? Does not the term ‘antinormal fold’ suppose the bending of a continuous layer of material, not necessarily the ore that follows a bedding-plane or sympathetic fracture, but the rock in which or the rocks between which the ore lies? The existence of such a structure in the disputed ground is assumed, although the lower court was decidedly hazy on the matter, if not averse from the idea. We may add that the present writer went underground on the day when Judge Averill’s decision was published and saw the chief evidence himself in the West End mine. If his opinion have any value, it is because it is unprejudiced and is based upon an unusual familiarity with ‘saddle-reefs’ in Australia and ‘domes’ in Nova Scotia, the two types of antinormal structure pre-eminently associated with important deposits of gold ore. In the West End mine he saw nothing to remind him either of the arches of quartz at Bendigo or of the domical formation at Waverley. Of course, these orebodies follow the bedding-planes of sedimentary rocks, itself an important difference from the conditions at Tonopah. But the law is going to have other problems that “escaped the foresight of Congress.” At Bendigo there is a series of antinormal arches trending eastward, in accordance with the dip of the antinormal axis. Which is the apex, the crest of each saddle or the antinormal axis that skewers a whole series, a dozen or more, of them? Usually the rock at the highest point of the arch is cracked, and along the crack, or cracks, quartz has been precipitated, so that some sort of connection between the arches can be inferred geologically even if not proved legally. Moreover, transverse cracks, now flatly dipping quartz veins, connect the vertical series of saddles; is the one on the hanging-wall side to be considered dominant and is the apex to be awarded to it? Here’s a pretty kettle of fish for any court that tried to apply that belated anachronism the law of the apex to conditions so far beyond “the foresight of Congress.” And what of the domes? Given an orebody that followed the quaquaversal dip or domical structure of a rock formation such as that of the slate-quartzite terrain in Nova Scotia, what is the apex? A dome culminates not in a line but

in a point. Would not the extra-lateral right "flow downward" in every direction like the rain on an umbrella? We leave the problem to our readers.

Education Again

This subject is again presented to our readers in the lengthy abstract of an address delivered by Mr. Charles S. Howe, president of the Case School of Applied Science, a technical college at Cleveland that is coming into honorable prominence. We thought Dr. Howe's treatment of the question so much to the point that it deserved to be brought to the attention of the mining public through our pages. After all, few questions are more deserving of continued study than this. Education is on the operating table, as it were, and demands careful dissection at the hands of the experts, such as the chiefs of our teaching institutions. Technical education is yet in a juvenile stage, in its recent phases it is still immature, and every bit of earnest criticism helps. It has become the care of the State and of the Nation, having passed out of the dangerous patronage of private endowment. The task of the educator is a big one and terribly restricted by the element of time. Most of the elaborate schemes for giving young men a training adequate for the needs of a professional career break-down for lack of time. The necessity for earning a living, for becoming an independent self-sustaining member of the community, prevents most young men from remaining under special tutelage longer than three or four years after they have emerged from the high-school or other boyhood instruction. Many of us, long in the field, would like to return to the lecture-room and laboratory if only life were not so short. It is the old engineering problem of doing the best you can within a limited time and with limited means. And in the end we have to confess, with Dr. Howe, that "engineering education does not produce engineers." It only helps to make them. Some men are engineers by the grace of God, and education stimulates their natural faculties to the maximum of effective growth; others have no aptitude, they are innately fitted for other occupations or for doing nothing gracefully. We like the suggestion that one of the things that will circumvent old Father Time is to teach the young man where to find the information he may need in the course of his work. Not much can be given him in the way of information applicable to his daily requirements; in the short years of training he is taught to develop his faculties, rather than store his brain; and one of the most useful of those faculties is the ability to find information as occasion demands. In these days of voluminous publication, in the form of books, transactions, and periodicals, it is highly important for the young engineer to learn how to extract from the vast mass of printed matter such portions of information as can serve him best. To know everything is impossible; to know where to find the necessary information is a first aid to successful technical accomplishment. And here we confess that we wish that indexes and bibliographies were better done.

Most of them fail by being indiscriminating, giving so little hint concerning the reliability, scope, or timeliness of the information. We need an index of indexes, something to guide the seeker after trustworthy data on any given subject. No editor but is aware of the difficulty of searching for information in the jungle of non-descriptive titles and incomplete references that are his only guide, outside personal memory, in such matters. A more contentious phase of the subject is instruction by means of laboratories and extensive equipment of plant in the technical colleges. We confess to philistinism in this regard. Many schools have a lot of elaborate apparatus on a scale so large that continuous demonstration is impracticable on account of the labor required and the material consumed. We know of several mining and metallurgical plants that are white elephants for lack of ore to keep them going, not to mention the difficulty of obtaining experienced men to run them and to instruct the students intelligently in the use of them. The average exhibit of machinery in a mining school serves to advertise the manufacturers that were enterprising enough to donate specimens of their products and affords the students a measurable amount of physical exercise indoors. In after life the least practical men are apt to be those that have tinkered with such apparatus under an academic instructor. The better plan is to take the young men to the mine and mill, to put them in touch with actualities, and to teach them the purpose of it all by contact with working conditions. A wise compromise is to use not the full-scale exhibits of the manufacturer, but model plants on a scale so small that the machinery can be taken apart readily and studied conveniently. A small model will illustrate the essential principles just as well as a ponderous machine, it saves material and labor in the running of it, and it enables a variety of types to be studied without wasting the restricted space usually available for the purpose.

In the discussion that followed the address of Dr. Howe, a reference was made to the standing of the lawyer and doctor as compared with the engineer, to the disparagement of the last. Is it not a criticism on his education that he should, as a citizen, fail to have the standing of those in the allied professions? In France and Germany the title of mining engineer commands respect because it presumes a good education, not only technical but humane. That is true of the lawyer and doctor, both of whom are equipped to take part in public life. It is assumed by many that the training for the work of engineering is so insistent that no time is left for a broad cultural education, that the bread-and-butter earning must be assured and when that is done it is too late to become familiar with good literature, political philosophy, and a completeness of mental life. Nevertheless, the education of the mining engineer will be a failure unless it equips him not only to win a wage when he graduates, but to take a leading part in the community when he is twenty years older, to make him not only a successful technician but an effective citizen—a leader among men.



DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Surficial Indications of Copper

The Editor:

Sir—Mr. Probert has presented a valuable summary of the prominent features of secondary enrichment, covering a wide field with discriminating observation and simple statement. His papers, however, seem to accentuate the paucity of our knowledge in regard to the connection between kind and character of outcrop and kind and importance of deposit beneath it. What the engineer is seeking, and what the capitalist expects him to possess, is some body of rules which shall suffice to decipher from the superficial record the history of the changes below the surface that have made for the genesis or otherwise of mineral deposits. Outcrops vary within the widest limits in their character, even when there may be similarities in ore deposition beneath. Only in the cycle of chemical reactions operative in producing secondary enrichment is there an approach to uniformity. The number of secondarily enriched deposits in the world that has been studied has been insufficient for accurate reading of the lesson of the outcrop. A man passing from the Utah Copper to the Miami, and thence to the Ray, and the Ajo, meets with a series of unlike superficial conditions, and the world knows the story of hesitant engineers in the face of these variant phases.

This only serves to emphasize the importance of the discussion which Mr. Probert has initiated. After a mine has been proved, more attention is devoted to the underground disclosures than to a detailed study of why and how the outcrop may have indicated what lay below, but the knowledge of these relationships is precisely what the world needs as a help for finding another, and yet another, mine.

Mr. Probert calls attention anew to the favorable conditions presented by prolonged and intermittent vulcanism, and by a succession of moderately basic intrusions, followed by acid, and terminating in more basic eruptions. While generalizations are easily misleading, evidences such as these naturally induce to careful study of a region, particularly when indications of actual metallization are found in conjunction with them. Not infrequently the really valuable deposit presents fewer signs of metal at and near the surface than appear in the minor veins and zones of mineralization in the neighborhood. An investigation into the geological structure of a promising district is often the key to the discovery of an important mine.

In connection with conditions favoring ore deposition and the marks left on the surface it may not be amiss to call attention to one feature which is frequently valuable as a means of interpreting the more salient phenomena. Primary ore, preceding concentration into secondary enrichments, was not likely to present spectacular effects. Rare and striking examples of mineralization were usually absent. The outcrop examined for evidence of the relatively feeble primary mineralization may, however, disclose significant indications in portions of the rock which have not participated in those katamorphic changes that favored the leaching of the early metallic sulphides. Here the microscope is an essential aid. Even the binocular will often afford nearly conclusive evidence in the field in advance of the final revelations by laboratory study on thin sections. Mineralization of extensive copper areas has usually taken place under conditions of moderately high temperature and pressure. The metallization, moreover, has ordinarily been a product of replacement, accompanied by extensive alteration of the rock-minerals, even where the latter have not been involved in the metasomatic reactions. Important quantities of magmatic gases, occluded at high pressure in the original minerals of the rock, become liberated in this process of alteration under the influence of the later ore-depositing so-called 'mineralizers,' and these gases enter into the cycle of chemical changes. The carbonic acid gas, commonly the most abundant of the occluded gases, forms carbonates and sets silica free; while the hydrocarbons, also abundant as occluded magmatic gases in the rock-minerals of igneous rocks, perform their important function as reducing agents. The importance of the alterations throughout the mass of a rock undergoing mineralization by later invasions of heated gases or solutions as a result of the participation of the original occluded magmatic gases, is very great. A cumulative intensity of alteration results, and where a wide extent of fairly uniform high-temperature alteration is accompanied by metallization, it has generally been assisted in no small degree by the earlier occluded gases. Remnants of denser rock masses in proximity to areas of mineralization, that have resisted erosion and decay by reason of their density, may throw light on the genesis of indicated ore-bodies, and help to confirm the indications when taken in conjunction with the structural features of the region. When the remnants of primary rocks still contain occluded magmatic gases at or near the outcrop, the conditions for original (primary) mineralization, and

for the subsequent alterations which promote secondary enrichment, are relatively unfavorable.

The mining world is awaiting, with keen expectations of the solution of many a riddle, the treatise on sulphide enrichment now being prepared under the general direction of Mr. Graton. In addition to this it is to be hoped that Mr. Probert will include in the program of the University work under his charge, a continuation of his interesting study of the outcrop-criteria of orebodies, until it bear fruit in a monograph which will become a valuable practical guide for the engineer in the field.

COURTENAY DE KALB.

Tuesday, June 27.

The Discovery of Cyanidation

The Editor:

Sir—It was my good fortune to be a contemporary of Mr. MacArthur in the Tharsis company's laboratory at Glasgow from 1872 to 1879, when I left to take a position with the Sierra Buttes company in Sierra county, California. We had always been 'chummy' while working for the Tharsis company, and the friendship was continued by frequent letters after I came to California. His told me of research work he was doing on the Tharsis ore, and mine told him of the simple methods of treating the auriferous sulphides at the Sierra Buttes.

In the early days of that mine no concentration was done because it was not necessary; but as depth was attained, and the quantity of unoxidized sulphides increased, something had to be done to recover the gold in them, and in the 'seventies Hendy 'jiggers' were put in. The concentrate saved on these was spread out on platforms below the mills, mixed with salt, and allowed to weather for several months, then re-ground in amalgamating pans. This was the method I told MacArthur about and I am sure it must have seemed very primitive to him against the condensing-tower recovery practised by the Tharsis. As the proportion of ore crushed from the lower levels increased, the percentage of unoxidized sulphides increased also, and in the early summer of '84 the first shipment of concentrate was made to the Pioneer Reduction Works at Nevada City. The returns were so satisfactory that along about '85 the Sierra Buttes company put up chlorination works of its own below the Yuba mill, which was equipped with Fruevanners when it was built in 1883.

Meanwhile MacArthur was "pegging away" at his cyanide process, and in the fall of '86 he asked me to send him a small sample of Sierra Buttes concentrate. This I did, and probably it was the first product of a California mine to be cyanided.

In March '89 he wrote me that he was coming to the United States and that, after attending to his patent business at Washington, he would come to California to look over the ground and see what the prospect was for the adoption of his process in this State. It was with the greatest pleasure that I looked forward to meeting

my old chum again. As he came with gilt-edged credentials, it was no trouble at all to get the Sierra Buttes management in San Francisco to give him *carte blanche* for experiments at the mine—and so I had the honor of introducing the discoverer of the cyanide process to a gold mine.

In his tests at Sierra Buttes, and at the Plumas Eureka also, where we went later, he stuck resolutely to the custom he had established in the early days at Glasgow of "laying the gold on the table"; but, it need hardly be added, he didn't forget to assay the tailing.

In his experiments at both mines the extraction was uniformly satisfactory. There was only one noteworthy fact the significance of which none of us saw at that time. In the mill there was the usual system of boxes, below the concentrators, for saving the sulphide slime, which assayed away above the average concentrate, and the extraction was also very high. This indicated the advantage of fine grinding, but, as far as I know, none of us looked upon it as anything more than a splendid exhibition of the potency of cyanide to dissolve gold.

The Sierra Buttes management was nothing if not practical, so that, without doubting the scientific truth of MacArthur's claim for his process, they looked at him with indulgent incredulity when he spoke of its becoming a commercial success. At that time (1889) MacArthur told me he knew quite well that the cost of cyanide (it was then about 3 shillings per pound in Britain) was a serious obstacle to the general adoption of his process for the treatment of even moderately high-grade material; and the problem he had set himself then was to find some process to cheapen the cost of manufacturing it.

While in California MacArthur heard of the wonderfully rich but refractory and rebellious ore of the Meadow Lake district and he commissioned me to visit that decayed camp, as soon as the snow was off the ground, and get some samples. When I got to Cisco, I inquired about a means of getting to Meadow Lake and incidentally told the hotel people the object of my quest. They looked at me rather pityingly as if they thought I was sent on a profitless mission, but arranged for a guide and saddle-horses. Capt. Hartley received me kindly, gave me lunch, which I needed, and let me take the samples I wanted, and I returned to Cisco well pleased with my day's work. I learned the meaning of the pitying smile of the morning when the proprietor told me that Capt. Hartley's usual reception of any unaccredited visitor who went to him for samples and information about his property was to drive him off the premises at the point of a shot-gun. The samples were taken at random from shallow pits and open-cuts along the croppings without any attempt at system, the purpose being simply to find out if this rebellious ore would yield to cyanide solution. Some of the samples were fairly rich, others quite poor, but they all yielded readily to cyaniding. Nothing came of the Meadow Lake business for the reason that Hartley wasn't buying processes and the Cassel company wasn't buying mines.

In the fall of '89 I was at Crestone in Colorado when the advance guard of the Cassel company pitched its first camp in the United States. At Crestone I met P. George Gow, who four years later was in charge of the Cassel company's exhibit at the Midwinter Fair in San Francisco. In the summer of '93 he came to Grass Valley and took samples of North Star tailing for a working test at the Cassel company's experimental plant at the Fair. His report was that the North Star tailing was too low-grade to cyanide at a profit. Now the North Star company is cyaniding thousands of tons profitably every month. As MacArthur states in his article, there has been no radical change of, or addition to, the process since '88, but improved mechanical methods have made the difference between profit and loss.

THOS. MARSHALL.

Grass Valley, June 29.

An Earthquake in Nevada

The Editor:

Sir—I have read the account of the earthquake at Kennedy by S. L. Berry. It is also true that we still have quakes and rumbles every day. At Winter's ranch, six miles below here where there are hot springs, there are 15 and 20 shakes a day right along since October 15 last. Lately we have had quite a few rumbles and jerks, but not heavy enough to do damage; Kennedy is 30 miles south of here. The earth is cracked all along the foot of this range on the north-west side of the Stone House valley, two miles below here. It is also true that water is running in creeks and gulches where the old-timers have never seen it run before.

LORING HANSON.

Golconda, Nevada, July 12.

Prospecting: A Suggestion

The Editor:

Sir—"What's Wrong with Prospecting?" has become a familiar caption in the mining press. We have read the lamentations of those who mourn the passing of the old-time prospector until many mining men have come to feel that much of this vain yearning for 'the good old days' bespeaks negative suggestion. Yet the recent renaissance of mining has encouraged prospectors to resume their ancient and honorable calling. Exploration companies and syndicates had been setting the pace because they alone knew the value of expert prospectors in their organization. Metallurgists, chemists, assayers, and other surface men, knowing the actual commercial values of ore deposits, have blossomed forth as 'prospectors' of the new school. The use of the mining engineer for directing explorations for small operators has not been emphasized.

Let us consider a hypothetical mineral district worthy of exploration, such as the partly prospected and developed mineral district in the Siskiyou mountains, California. This region has been skimmed over by pros-

pectors for gold, copper, and lead during the past fifty years, but their work was desultory in character. With the extension of motor-truck transportation, considerable activity is being aroused. Prospectors are renewing their efforts as individuals, but their explorations would be far more effective if co-ordinated. This is the field in which the exploration syndicate could operate with good prospects of success.

Here is how the old and new methods of prospecting will compare. Probably a score of prospectors within a year will visit a particular portion of the Siskiyou mountains, an area 20 miles from east to west and 14 miles from north to south. Several of them will undoubtedly follow outcrops and locate a number of claims. Suppose that four or five men out of twenty locate claims that give promise of becoming paying mines. Of these, only one individual prospector succeeds in getting enough backing to develop his property. This 1-in-20 chance is a fair proportion. The other 19 spend from \$5000 to \$10,000 to no purpose. Even the one lucky one has made a random hit. He may have passed over dozens of richer deposits in his hurried wanderings. Most of the unlucky 19 are backed by investors who have 'taken a chance.' Some of these losers are not good losers and they seek solace in calling mining a 'losing game.'

Co-operative prospecting, on the other hand, might be conducted in a radically different manner. Let us assume that this particular district is worthy of systematic exploration for a summer. What would it cost? Suppose that a group of 20 investors subscribe a total of \$5000 to an exploration company and plan to devote that sum to a thorough reconnaissance of the district. They make a wise start by employing a mining engineer who is qualified to conduct a geological survey and to direct the efforts of prospecting parties in the more promising sections. He spends the month of June in traversing the ridges and canyons of the region with a skilled assistant and a handy man who combines the services of a packer and camp-cook. At the end of June he defines three zones, X, Y, and Z, as areas in which he proposes to confine the efforts of three experienced prospectors. Each prospector has a man to help him, and, besides a fair salary, has the additional incentive of a bonus of from \$500 to \$1000 offered him for the making of a 'strike.' A regular cook is then employed at a base camp, while a packer travels from camp to camp carrying provisions and supplies to each station as well as from the railway or stage shipping point. The engineer's assistant helps in the field-work, in mapping, and in making assays at the base camp.

By the end of July, prospecting in zones X and Z does not show results, but the prospector in zone Y discovers a series of outcrops trending in a north-westerly direction from the middle fork of Creek B across the divide to the east fork of Creek D, a distance of six miles. A distinct silicification is traced along the line of a fault traversing this favorable formation. The four men covering zones X and Z are called in and set to work exploring the vein system discovered in zone Y. Let us

assume that the original strike was made at the middle fork of Creek B. Subsequently, the prospector from zone Z discovers an extension a mile below the head of the North Fork and the largest and richest orebody is proved to exist there. Exploration work is then concentrated there during August with the result that the driving of several hundred feet of tunnels and the sinking of shafts with cross-cuts demonstrate the existence of 150,000 tons of ore having an average value of \$8 per ton. Prospectors Y and Z share ultimately in a bonus of \$1000 paid them in the same way that salesmen working on a salary and commission basis earn their bonuses for sales made. Prospector X is not so fortunate, but he may benefit by working into a steady job when the mine is developed. A number of claims are staked in zone Y and the exploration company has something to show by the end of August. Here is the cost sheet of this theoretical reconnaissance:

LABOR AND SUPERINTENDENCE

	June	July	Aug.	Totals
Engineer in charge.....	\$250	\$250	\$250	\$750
Assistant to engineer.....	100	100	100	300
Cook and packer.....	75	...	...	75
Regular cook .....	...	50	50	100
Regular packer .....	...	60	60	120
3 prospector-miners at \$90.....	...	270	270	540
3 muckers at \$70.....	...	210	210	420
	\$425	\$940	\$940	\$2305

OTHER EXPENDITURES

Provisions	\$ 50	\$150	\$150	\$350
Camp equipment.....	150	125	25	300
Mining tools	25	75	50	150
Powder, caps, fuse.....	20	80	200	300
Assays and assay equipment....	50	300	50	400
Transportation	150	100	100	350
Miscellaneous expenses	50	75	75	200
	\$495	\$905	\$650	\$2050
Grand total	\$920	\$1845	\$1590	\$4355
Balance in treasury.....				\$645

Assuming that a bonus of \$1000 is due prospectors Y and Z, the total cost of such systematized prospecting would, according to these convenient figures, amount to \$5355, to say nothing of a tidy little bundle of stock certificates in the re-financed company which the engineer ought to have coming to him.

Of course this theoretical prospecting trip had to result in the discovery and blocking out of an orebody that showed up 150,000 tons of \$8 ore. Furthermore this ore must be supposed to yield a net profit of \$3 per ton after an additional investment in surface equipment and working capital is made. This figures out very nicely as a business proposition in which the original investors and their financial allies subscribe just \$105,355. Even if they do not open up new orebodies and confine their operations to the proved deposit, there is the difference between \$150,000 gross profit on ore extracted and the total investment of \$105,355, a net return of \$344,645 on such enterprise. If it takes seven years to exhaust

this orebody, there would be a net profit of 327%, or 46% per annum, on the investment. Now, if the original 20 men who raised \$5000 for such systematic prospecting were to sell their mining land for what it would be reasonably worth, \$75,000, they would clean up 1500% on their speculation. As a business enterprise this beats 'hogs and alfalfa' or 'bees and wild honey.'

Mr. Doubting Thomas, taking a contrary view, may say: "Suppose the original reconnaissance party of three, after a June outing in these delectable mountains doesn't find any 'zones' like X, Y, and Z worth further exploration." They will be out of pocket, but only to the extent of \$920. Divided between 20, the average loss would be \$46. If these twenty had separately 'grub-staked' 20 different prospectors for the same amount, approximately \$5000 in all, their loss would have been \$250 per capita and their chance of sharing in the half-interest proposition of the old-time prospector relatively less.

HAROLD FRENCH.

Oakland, June 30.

ROCK-DRILL practice on the Rand usually works out differently than in the United States. In the Transvaal, the miners are Kafirs drilling exceptionally hard rock in flat narrow stopes. New devices are apt to be looked at askance, as these miners do not take readily to complicated mechanisms. Recently the electric firing of blasts was tried on a thorough scale at the Meyer and Charlton mine where conditions were believed to be favorable. The experiment was unsuccessful, and the electrical equipment was removed. The blasting of so many holes simultaneously injured the hanging wall and misfires were common. The *South African Mining Journal* reports that "interest has been aroused among engineers and mining men on the Rand regarding the application to rock-drills of the newly discovered method of transmitting power known as wave transmission." As yet this new method of applying power to drilling rock is said to be in the experimental stage, and details have not been made available.

THE CALUMET & HECLA company, which recently celebrated the 50th anniversary of mining on its lands, awarded gold, silver, and bronze medals to its oldest employees. Over 160 men have worked for the company from 40 to 50 years, and one man, Timothy O'Shea, has worked 50 years and six months. Several hundred have worked 30 to 40 years and nearly a thousand have worked 20 to 30 years. In an age when labor is restive, these figures are particularly noteworthy. Among the old employees are such Cornish names as Edyvean, Johns, Jory, Trevorrow, Thomas, Tonkin, Cuddihy, James, Nancarrow, Richards, Soddy, Trathen, Bennetts, Williams, and Penhall. Other nationalities among the veterans include Kelly, Doyle, Dooley, Carlson, Govette, Koch, Kjolso, Kruska, McLean, MacNaughton, Venturino, Swanson, Pyrrhus, Abramson, Jolicœur, Marchetti, Salotti, Baranowski, and Campbell.

The Bolivian Tin Industry

By Howland Bancroft

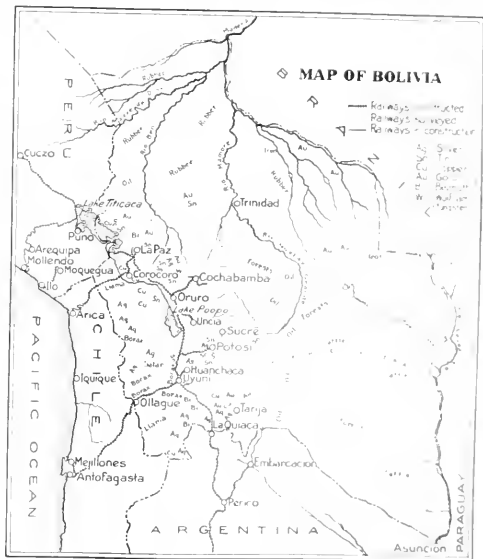
INTRODUCTION. *Interest in Bolivia as a source of future supply of tin for the increasing demands of the United States began to appear when production from Bolivia exceeded for the first time the combined production of Banka and Billiton. Prior to 1905 the production of these Dutch colonies was second only to that of the Malay Straits. In 1905 the Bolivian production passed 16,000 metric tons of metallic tin¹ while the production from Banka and Billiton fell from the record figure of 20,000 metric tons in 1903 to 12,000 metric tons in 1905, since which time their combined production has not equaled the Bolivian output. In 1897 the Bolivian production first commenced to be an important factor, and this output has persistently increased.

Since my first trip to South America, I have seen many improvements accomplished in the railroad system of Bolivia, while outside the Republic marked progress has been made in the treatment of the ores by those interested in obtaining a clean product, in order that Bolivian ores might command as high a price in the market and be as suitable for use in the tin-plate industry as those from other, and, I might say in this respect at least, more favorably known localities.

The declaration of war in Europe caused some speculation in the United States in regard to the supply of tin for domestic consumption. As Great Britain controls a majority of the world's production, a possible embargo on the exportation of this metal was anticipated with a foreboding that proved correct. When the embargo was put into force by Great Britain, it became evident that Bolivian tin ores could not be safely shipped to Germany for reduction, and, to cap the climax, British smelters raised their charge fully 80%. In consequence, a great hue and cry was raised in Bolivia as to who would smelt their tin ores. Much discussion followed and a great many communications were exchanged regarding the erection of a tin smelter in the United States. Several groups talked about undertaking this, but to date, only one company has done anything toward actually building a smelter.² In 1915, the American

Smelting & Refining Co. began constructing a tin smelter at Perth Amboy, New Jersey; it went into operation in March 1916. This plant has a capacity of 8000 to 10000 tons of metallic tin per year, or a little less than two-fifths of Bolivia's present total output, the remainder of which will doubtless be smelted in British furnaces until the end of the European war, after which American, English, or German tin contracts with Bolivian producers will depend largely on the prices offered.

WORLD'S PRODUCTION OF TIN.³ Reference to Fig. 1⁴ will show the production of tin from different countries of the world. It will be seen that the Malay States, or,



as they are also known, the Straits Settlements, produce somewhat more than half of the total, while the combined production of tin in British possessions and protectorates amounts to about 60% of the world's production. Next in importance is the Bolivian output, which in

requesting special concessions for treating the Bolivian output in electric furnaces to be erected in the Republic. However, as yet no announcement has been made of the erection of a plant to smelt tin ores electrically.

All generalizations regarding productions, values, and prices refer to normal, not war, conditions.

Frank L. Hess of the U. S. Geological Survey kindly consented to bring the figures 1 and 2 up to date from 1912, as I was not in the United States until a few days before the presentation of the paper, and such statistical information was not conveniently at hand in the field.

*A paper read before the second Pan-American Scientific Congress at Washington, and revised subsequently by the author.

¹Throughout this paper references to productions of tin are to metallic tin, not to the concentrate or 'barilla' from which the tin is obtained.

²It is to be remarked that four United States companies offer to treat Bolivian tin ores, two of which contemplate smelting these ores in electric furnaces. Furthermore, a French commission has studied the available hydro-electric power possibilities in Bolivia with a view to erecting smelters there. Also, a considerable amount of agitation is apparent in the Bolivian capital regarding bills introduced to Congress

1913, passed 25,000 metric tons, or about 20% of the world's total. Banka is the only other country having a production that exceeds 5% of the world's total, and in 1912 Banka was credited with a yield of about 16,000 metric tons, or 13½% of the total. Cornwall, Australia, China, South Africa, and Billiton make up the remaining 17% of the world's output, and, as above stated, the individual productions of each of these countries is less than 5% of the tin production of the world.

On the same diagram will be seen a curve representing the total amount of tin produced in countries other than British possessions and protectorates, a curve showing the consumption of tin in the United States, and also a curve illustrating the value, in millions of dollars, of the world's production of tin between the years 1897 and 1915.⁵ Some notable facts are illustrated by these diagrams. For example, the total amount of tin produced in countries other than British is less than the amount consumed in the United States, and has been less during the period covered by this diagram. Further, in the last few years the value of the world's production in millions of dollars has been about equal to the world's production in thousands of metric tons. In other words, during that period the value of a thousand metric tons of tin has been, in round numbers, one million dollars. In this connection Fig. 2 will be of interest; on this diagram is shown graphically the average monthly price of tin at New York during the period covered by Fig. 1, namely, between 1897 and 1915. It will be observed that the price, with some exceptions, has risen steadily from 13 cents per pound in 1897 to over 50 cents per pound in 1912 and 1913, since which time it has fluctuated between 50 cents and 30 cents.⁶ Between 1897 and 1915 the world's production has increased from 75,000 metric tons to over 120,000 metric tons of tin. This continued increase in production, accompanied by a more or less constantly advancing price, is worthy of especial remark.

UNITED STATES CONSUMPTION. Since 1897, or, in the last 19 years, the importation of tin into the United States has increased from 25,000 metric tons to over 50,000 metric tons, having passed this figure in 1912. The growth of domestic consumption has been due largely to the steady growth of the American tin-plate industry, although the large use of tin tetra-chloride in the silk industry has had a considerable effect on the amount of metal consumed. During the same period the British tin-plate industry has decreased proportionately, the protective tariff in the United States being not only responsible for the rapid growth of our own tin-plate industry, but also for the decline in that industry in Great Britain, from which country the United States purchases 90% of the pig-tin it consumes. The United States Steel Corporation is the largest individual con-

sumer of tin in the world, the American tin-plate industry having been developed by this corporation. It is to be remembered that the available supply of tin from nations other than British possessions and protectorates is less than the amount consumed annually by the United States.

Here follows a brief statement regarding secondary tin in the United States. This industry has grown from a small beginning in 1900 to such proportions that the secondary tin recovered in 1913 equaled 14,178 tons, valued at \$12,567,379, and the recovery for the year 1914 was 12,447 tons, having a value of about \$8,887,158. These figures represent respectively 27.2% and 26.2% of the importations of tin into the United States and indicate a constantly increasing domestic source of tin supply. J. P. Dunlop states:⁷ "The recovered tin includes the tin content of products made by several plants from tin scrap. These include some tin oxide, putty powders, etc., but consist mainly of tin chloride, stannic and stannous salts. Stannic chloride is usually sold either as a water solution, called bi-chloride of tin, or as an anhydrous sirupy liquid, termed tetra-chloride of tin, and is used principally in the silk industry. Stannous chloride is sold in the form of crystals and is used in dyeing and calico printing. Most of the tin oxide, tetra-chloride, and other products were made from clean tin-plate clippings, or from tin liquors left in dyeing and weighting silks. The dry chlorine process was used to recover the tin from the clippings in some places; in others reverberatory furnaces were used to remove the tin coating, and a large quantity of tin was recovered in the form of a tin powder by the electrolytic treatment of clean scrap, the powder being sent to secondary smelters. The largest recoveries of tin were made from the scruff and drosses that occur in making tin and terne plate, and amounted to over 5000 tons. The recovery of tin from block tin pipe, tin foil, and old tin cans was relatively small. Only one firm reported using old tin containers, from which the tin and solder were first sweated and the black plate re-melted to make sash-weights. The principal alloys in which secondary tin was recovered were babbitt and other bearing metals, bronze, solder, pewter, and electrotype metal."

BOLIVIAN PRODUCTION. The production of tin from Bolivia in 1863 was only 493 tons,⁸ while the following year the output was only 204 tons, and it was not until 1888 that the annual production exceeded 1000 tons.⁹ The production from this date until 1898 fluctuated under 3000 tons per annum. Since 1898 the production has been almost continuously increasing until in 1913 it passed 25,000 metric tons. See Fig. 1. While a glance at this diagram would lead one to believe that the Bo-

⁵This period is chosen for the reason that prior to 1897 the Bolivian production was too small to be considered as important among the productions of other nations.

⁶During August, 1911, tin was quoted at 65c. per pound in New York. However, this price was maintained only for a brief period.

⁷Mineral Resources of the United States, U. S. G. S., 1912.

⁸All figures regarding production of tin refer to the amount of metallic tin contained in the ores produced and shipped, and do not refer to 'barilla,' in which form it is customary to refer to the production of tin in Bolivia.

⁹Mineral Industry, Vol. I, p. 450 (1892).

livian production represented normal growth, it is necessary to know certain pertinent facts regarding the actual production from the individual mines before coming to any conclusions regarding the stability of the Bolivian tin industry as a whole. For example, one mine produces roughly one-fourth of all Bolivia's output. A contiguous property could easily produce another fourth, but the policy of the management seems to be rather to keep to a nominal production of 12,000 quintals per month, this representing 17.3% of the total output from Bolivia. Of the remaining 58.7%, three-fifths comes from Huanuni, Compania Minera de Oruro, Araca, Aramayo Frank & Co., Soux, Bebin Brothers, and the Avicaya properties. A large proportion of the output therefore comes from a comparatively few mines, over two-fifths from two contiguous mines in one district. Consequently, the increased production from Bolivia is traceable to the efforts of two companies, and if they stopped operating the total output from Bolivia would drop to a third-rate place among tin-producing countries. The relatively small proportion of tin produced by the intermittent shippers, representing a little over 20% of the total production, comes from numerous properties, more than 25 others, which are not continuously operated, and which ship from a few hundred to a few thousand pounds of concentrate per year.

The reason that relatively few Bolivian mines produce tin in quantity seems rather to be due to a general lack of foresight and enterprise on the part of the owners than to a poverty of ore. Owners of prospects not blessed with much in the way of worldly possessions are usually not only too poor to develop but are likewise unable to pay taxes. In consequence, these so-called owners keep on denouncing the deposits over and over again, either each succeeding year, or often enough to complicate the titles. Further, any deposit so rich that it can be worked with profit from the surface is gutted without regard for the future. The natural and obvious result is that when the rich ore-shoot is mined, or when the grade falls off to such an extent that profitable mining is no longer possible with the crude and wasteful methods in vogue, there is no ore developed, no money for development, and no money available for the purchaser of equipment. The same generalizations hold, with possibly two exceptions, even among the few mines that are contributing four-fifths of Bolivia's total production. In consequence, we have here to deal with a few productive properties, none of which have any reserves assuring a continuance of output for any considerable period.¹⁰ In short, the Bolivian production has

gained its present importance through the development of a very few mines, which have practically paid from the grass-roots. Other properties are mere prospects and have no assured future. However, to one who has studied practically all of the properties of commercial importance, and has at the same time examined the region carefully, it is quite apparent that the Bolivian tin industry is still in its infancy. However, I believe that this industry, if aided by the Bolivian government in the enactment of just mining laws, regulations, and taxes, so that the foreigner¹¹ will not want to keep out, is destined to expand to first importance.

Just now the Bolivian government, in common with other South American republics, is financially hard-pressed, and, as a consequence, in attempting to mitigate

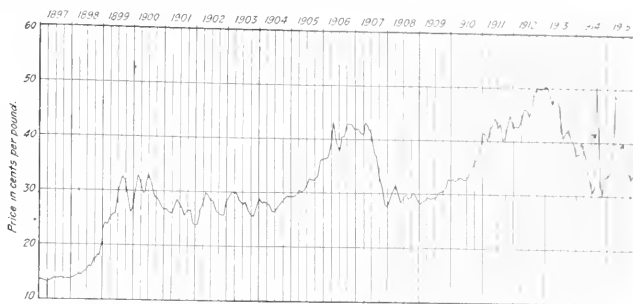


FIG. 2. THE PRICE OF TIN AT NEW YORK.

its troubles, it turns instinctively to the mining industry, which is really its backbone, although usually unappreciated. To raise money, Congress considered a law compelling all of the tin producers to buy 20% of their foreign exchange drafts (in payment for barilla exported through the National bank at the standard par value of the *boliviano*, which is fixed by Congress at 12.50 bolivianos for one pound sterling. This is all very well when the exchange on bolivianos is at par. However, when the law was being discussed, exchange was anything but normal, and this order, if passed by Congress, would have amounted to an added export tax of \$1,498,510 U. S. currency, which would be an appreciable addition to the export tax. To make this more clear: Under normal conditions the English pound sterling is worth \$4.8665 U. S. currency, and has a value in bolivianos fixed by the Bolivian government of 12.50 bolivianos. This makes a boliviano worth 38.93 cents U. S. Taking, for illustration, the present value of the boliviano as being 30.3c, the difference in its purchasing value and the value at which mine-owners, according to this law, might be compelled to buy one-fifth of all their drafts amounts to 8.63c U. S. for each boliviano involved in the transaction. Now, the tin industry re-

¹⁰While the production of tin from Bolivian placer deposits is small at present, there exist placer deposits that have been practically unexplored, although one large American company has done some drilling with unsatisfactory results, so I am informed.

¹¹Considerably less than 50% of Bolivia's tin production comes from Bolivian-owned mines, and of this portion only a small amount is produced from mines owned by a capable energetic Bolivian gentleman who lives in Europe; the rest of the Bolivian output is produced by mines controlled by men of foreign birth.

Bolivia has an annual gross value of roughly \$25,000,000. One-fifth of this is \$5,000,000. At the value of the boliviano as fixed by Bolivian law, \$5,000,000 U. S. equals 12,843,565 bolivianos. At the present value of the boliviano the same amount of money equals 16,501,650 bolivianos, a difference of 3,658,085 bolivianos or \$1,108,510 at present exchange. This would go through the Banco de la Nacion. The purchase of 20% of the drafts at the rate of exchange fixed by the Bolivian government would bring in an annual revenue of \$1,108,510. Now, as the production of tin in Bolivia is at present roughly 50,000,000 lb. per annum, and this added exchange amounts to 110,851,000 cents, it is equivalent to adding an export tax of 2.21c. on each pound of tin contained in the barilla exported, which, added to the already existing export tax on tin (which ranges from 0.86c. per pound to 2.08c. per pound, according to the London quotation on Straits tin) would make a total export tax ranging from 2.77c. to 4.36c. U. S., figures that are appreciable, to say the least, and that would undoubtedly have the effect of hindering, if not stopping, the exploitation of some Bolivian tin mines, for the simple reason that 4 cents gold per pound of tin produced is perhaps the limit of profit in many of the operations.

It is to be remarked that fortunately this legislation failed to become effective. However, the very fact that such a measure was proposed indicates an attitude on the part of the Bolivian government that is anything but conducive to the introduction of new foreign capital, and that appears rather hostile toward the investors already in the field.

OWNERSHIP OF TIN MINES. There are in Bolivia at present 9 or 10 mining companies producing tin concentrate in quantity. Of these, two groups produce 48.8% of the total production. It will be interesting to note the nationality of the control in these companies. Two are Bolivian, two Chilean, two French, two English, and one Italian. The two companies that are distinctly Bolivian produce in the neighborhood of 15,750,000 lb. of tin per annum. The two Chilean companies contribute about 12,300,000 lb. The two English and one Italian¹² mines produce about 7,150,000 lb., while the production of the two French companies is roughly 3,600,000 lb. The total is 38,800,000 lb., or roughly four-fifths of the total Bolivian production.

In considering the importance of this ownership to possible relations with smelters in the United States, it will be interesting to know that one American smelting company has contracted for the total output of the two Chilean companies for a period of one year, and has also contracted for the output of one of the companies classed as English. This represents contracts for about 7000 tons of metallic tin per year, or 28.2% of the Bolivian production.

Prior to the War the price charged in England for

smelting Bolivian tin ores of a rather impure character ranged from about \$58 to \$72 per ton of material treated, which price was advanced from \$121 to \$145 when hostilities commenced. The American company offered a certain concern a two-year contract at \$97.20 per ton of material treated, but the offer was not accepted. Before the War a German house smelted tin ores for a Bolivian-owned mine for \$34.02 per ton and for a French-owned property for \$43.74 per ton, the difference in smelting charges being due to the impurity of the ores from one of the mines and to the difference in the amount of material treated for the two companies.

As long as the European war lasts the matter of getting Bolivian tin ores for American smelters should (barring adverse Bolivian legislation) be an easy one, and at present only 28.2% of the total output is under contract to Americans. By reason of the high smelting rate existing in England and the practical impossibility of getting tin ores into Germany for reduction, it seems reasonable to suppose that the Americans will have no difficulty in obtaining as much of the Bolivian tin product as they desire. On the conclusion of the War, however, the matter will be more serious, the American tin smelters will have to be prepared to stand strong competition, for the price of \$34.02 per ton formerly granted by the Germans does not represent the lowest possible price at which the same house could smelt these ores at a profit, and when again entering the market, they will undoubtedly be willing to accept a smaller profit in order to regain the business they will have lost through the erection of one tin smelter in the United States and the completion of others now planned.

It is my belief that the nationality of the owners of the mines will have nothing to do with the placing of their smelting contracts, except in the event of equal prices being offered, in which case presumably the contract would go to a house of the same nationality. However, granting this, the English, so mixed up in tin smelting, and the Germans, though not so heavily interested, control but a small proportion of the Bolivian output through mine-ownership, while Italian, Bolivian, Chilean, and French custom smelters do not exist. Hence the conclusion seems justified that Bolivian tin contracts will go to the highest bidder, regardless of nationality.

MINING AND MILLING METHODS. In general, Bolivian tin-mining methods are crude in the extreme. This statement applies with equal force to all but a very few of the mines at present important. All of the properties in Bolivia have been gophered in their upper and richer portions, and but few of the companies are at present attempting to mine along improved methods. Furthermore, in many instances, instead of following a vein on a comparatively flat dip, circuitous inclines are sunk entirely off the vein. Naturally, the lode is not exposed, and if ore is again encountered, it is impossible to say with any degree of certainty whether it is the same orebody worked above or not. This makes little difference to the owner, as he will mine any ore so long

¹²The production of the English and Italian companies is given as a total to avoid disclosing actual individual productions.

as it is profitable. However, to an examining engineer such methods are confusing and unsatisfactory to the last degree. This hand-to-mouth method of mining leaves little in sight for the future, and is a serious hindrance to further exploitation of the mine after the richer portions have been mined out. The properties will then remain idle until someone with a little more energy and money takes hold, and by dint of more gophering manages either to lose his money or perhaps luckily uncovers another ore-shoot, in which event everything goes along as before until the ore-shoot is worked out. No money seems to be saved for just such contingencies, and with the almost complete lack of development the pinching out of an orebody may mean disaster to the company. At this point the owners are willing to sell, and seem to fail to understand just why American engineers do not evince more interest in their deposits, the skeleton of which is shown with the verbal record of past production! Furthermore, the owner seems disinclined to listen to any kind of purchase price other than one at least equal to what he imagines the mine has produced in the past, although nine times out of ten, he will be unable to show any authentic record of what this production has actually been.

Lack of surveys, unfamiliarity with the type of deposit being mined, and the absence of a scientific study of the nature of the veins or the possible extent to which such veins will be productive may be responsible in some measure for the peculiar mining methods in vogue. More probably they are the direct result of the methods introduced by the Spaniards some three centuries ago. Indeed, this brief description of Bolivian mining methods would be incomplete if I failed to draw attention to the unique mining methods that prevail at the Cerro de Potosí, a mountain that has probably given more mineral wealth to the world than any other. Here the old Spanish *boca mina* law is still followed literally, though not in the spirit of the law. Our own apex law is bad enough, but the *boca mina* (mine-opening) law caps the climax for absurdity. For example, the right to a mine-opening is granted by the State. Then the miner may go wherever he pleases underground, so long as he does not cross a previous underground passage. The result naturally is that the underground development more closely resembles a jig-saw puzzle than a mine, for, on breaking into a previously existing opening, the second operator simply goes around this in the event it is a shaft or winze, or, if it happens to be a level, he goes over or under it and continues. This leads to anything but peaceful mining conditions. Riots have been common, and pitched battles have taken place underground. Resort to arms is not confined to the Potosí district, however, for nearly every important mine in Bolivia has had some sort of an armed fight with its neighbors, and rifle racks are still to be seen in the administration buildings at some of the prospects.

The question of the amount of erosion that has taken place since the veins were formed is one, I venture to say, the importance of which has not even impressed

itself upon the minds of the operators, and so quite naturally, no attempt has been made by the Bolivian operators to gather sufficient data upon this very important subject. Since little money is expended purely for development, this lack of appreciation of the value of knowledge concerning the possible depth to which the veins can be expected to be productive has caused no great waste of money. However, long adits have been attempted, in fact, are at the moment being driven, and a careful study of the genesis and mode of deposition of

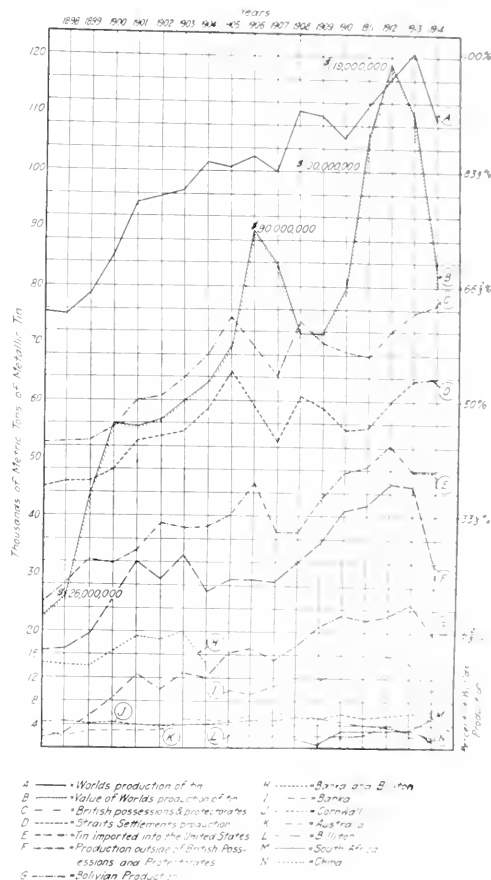


FIG. 1. THE PRODUCTION OF TIN BY COUNTRIES

the tin ores in each particular case would have determined the logical place for these adits, and would have made some rather expensive holes of much more practical value.

Although several so-called up-to-date mills are in operation in Bolivia, the loss in the tailing is remarkable, the cause for this being disputed among the managers. Some lay it entirely at the door of the native millmen, who, they justly claim, will at times allow the concen-

trate from the tables to run for hours into the tailing-box, with the natural result that the saving is low, and the tailing contains appreciable quantities of tin. I am inclined to believe, however, that these losses are largely the result of a misunderstanding of the possibilities (limits) of the machinery installed, in other words, a lack of expert administration, for few of the mills have men in charge that have gained their experience elsewhere. I talked with several managers who had never visited other properties in the same district, and few of them are conversant with the mines and mining conditions existing elsewhere in Bolivia. This does not tend toward efficiency, and the owners are more to be criticized in this connection than the managers, to whom too much work is frequently detailed to allow of their going about to see what class of ore others are treating and how successfully they are accomplishing their purpose. It all harks back to the gophering hand-to-mouth method of mining, the axiom being: "Spend as little as possible in any direction, and get as many quintals of barilla with as few laborers as you can and with as little foresight as is convenient." This seems like a severe criticism, but I speak advisedly. While Bolivians are good miners in that they produce good ore and concentrate at a small initial expense, they do so with a tremendous loss of resources and no conception of efficiency in its broader sense.

SMELTING IN BOLIVIA. Until quite recently tin ores were smelted in water-jacket furnaces at Potosi, the impure product being shipped to Europe. It commanded a lower price than Bolivian tin made from barilla shipped direct to Europe, and smelted there, and, as a consequence, a short time ago the Potosi shipper was notified that the European buyer preferred to receive only barilla, since which notification no bar is believed to have been shipped from Bolivia. (The completion of the Potosi branch of the Antofagasta-Bolivia railroad has allowed of the cheaper and more expeditious handling of freight, and so the former absolute necessity of reducing the bulk as much as possible on all freight shipments from Potosi is not now so urgent.)

Sometime before the War, a French commission arrived in Bolivia to study the available hydro-electric power possibilities of that country with a view to erecting electric tin smelters. The Government looked upon the project with a considerable amount of favor, and undoubtedly gave the commission certain unofficial encouragement. Following the War, however, the French commission, realizing the impossibility of carrying out the project during European hostilities, released the Bolivian government from any obligation. Subsequently two bills were introduced to the Bolivian Congress by representatives of two different United States companies, both of the bills having for their object the establishment of tin smelters to smelt tin electrically. These bills were too general in their demands, and too sweeping in their nature, to allow of favorable consideration. Because of the desire on the part of the promoters of the projects to establish a limited monopoly on the Bolivian tin output,

other requests have been made with a view to keeping the barilla within the country until after it has been smelted in the proposed electric furnaces, none of the plans for the erection of which seem to have been at all thoroughly elaborated. I believe that any sort of a monopoly on the smelting of Bolivian tin concentrates will only ensue from the actual erection of furnaces of sufficient size to treat the total output, and this will have to be obtained by the offer of competitive rates to the ore-producers, in other words, ordinary business practice. I am inclined to believe that the Bolivian government would look with considerable favor upon the erection of tin smelters within its borders, and if they proved beneficial to the industry as a whole, that is, in other words, to the Bolivian government, there is little doubt but that they would receive full protection from Congress.

PRODUCTIVE AREA. Argentine, Chile, and Peru have many geological relationships in common with those of the tin-producing districts of Bolivia. Notwithstanding this, Bolivia is the only South American country from which there is an appreciable production of tin ore, although cassiterite has been found in the mountainous districts in all of the contiguous republics, and it is to be expected that mines will be developed in these countries in the future.¹³ While tin ores are found over an area that covers 100,000 square miles of the Bolivian mineral belt, the principal properties are in the departments of Potosi, Oruro, and La Paz. Between the main ranges of the Andes broad flat pampas extend for many miles, the mean elevation of these being 12,000 ft. above sea-level. Some of the peaks in the ranges that bound these pampas rise to elevations of over 20,000 ft.; the average, however, being considerably nearer 15,000 ft. Tin ores are found in localities scattered throughout these mountains. In general, the deposits now being exploited occur between the elevations of 12,000 and 16,000 ft.; although in one locality such deposits have been exploited at an elevation of 19,000 feet.

CLIMATE. In general, the climatic conditions and high elevations do not tend to facilitate mining: the efficiency of human labor is reduced, a minimum of work is accomplished by beasts of burden, and the rated horse-power of all gas and other engines is decreased by from 3 to 4½% for every 1000 ft. rise above sea-level. Wind electrical storms of great intensity are frequent, and the rare atmosphere of the higher altitudes detracts from the efficiency of human effort. Several types of climate exist in Bolivia, depending largely upon altitude, though influenced to some extent by latitude. As nearly all of the tin properties in Bolivia are in the higher regions, we are concerned principally with the conditions existing between the altitudes of 11,000 and 16,000 ft. above sea-level. Two seasons are conspicuous, the rainy season, which lasts from November until March, and the

¹³Witness the tremendous expansion of the tungsten industry in Peru during the last six years, an industry dependent upon a metal the deposition of which is closely allied to that of tin. Argentine also has a tungsten industry.

dry season, from April to October. These two seasons are not marked by any considerable change in temperature and rains also occur throughout the so-called dry season. In the regions above 15,000 ft. no rain falls, the precipitation being in the form of hail or snow. It is quite possible to spend weeks at a time in the higher regions of Bolivia during the rainy season without once getting a glimpse of the sun. And it is to be remembered that all of the tin-mining districts of Bolivia are within the tropics, where the days are frequently uncomfortably warm and the nights dangerously cold.

VEGETATION. The tin-producing districts of Bolivia are barren of indigenous trees. Eucalyptus trees have been tried at altitudes up to 12,000 ft., and because of their rapid growth would prove of tremendous benefit within a comparatively few years if planted in large numbers. *Turba*, a sort of peat, serves as fuel, for which purpose a resinous plant called *yareta* is also used. However, the accumulations of *turba* are limited, and the growth of *yareta* is slow, while the consumption of both for use as fuel is high. Hence the supply is being rapidly depleted.

WATER. Properties situated near the snow-line are peculiarly favored in one respect at least, they have an abundant supply of water. In general, water is scarce in the tin-mining districts of Bolivia. However, there are running streams, and while these are not always conveniently situated, they afford, nevertheless, ample water for concentration works as well as for hydro-electric purposes.

TRANSPORTATION. The departments of La Paz, Oruro, Potosi, and Cochabamba are traversed by railroads over which combined cargo and passenger trains are run at sufficiently frequent intervals to take care of the business offered. However, if you miss a train you may have to wait a week to go 160 miles. Naturally, the completion of each projected branch facilitates shipments, and reduces to some extent the former freight rates. The railroads are notoriously high in their charges and there is still much to be desired in the way of reasonable freight tariffs. While the cart-roads in Bolivia are numerous, there are many properties to which no kind of road has been constructed. A few of the mines are well situated as regards railroad transportation, but the majority of the deposits are at a distance from railroad points, and the tin ore in the form of barilla is transported from these localities by carts, mules, or llamas. The bulk of the tin concentrate is carried at least 10 to 15 miles to reach a railroad station. Two-wheeled carts drawn by from 6 to 12 mules will transport from 2 to 3 tons, a mule will pack 200 to 300 lb., and llamas carry about 75 lb. each. The wet season interferes with transportation by carts as well as by mule-back, and during very dry seasons the llamas find it difficult to obtain sufficient food on the journey.

POWER. Because of the scarcity of fuel and its consequent high cost, various means of generating power have been attempted. Steam, generated by burning *taquia*, *turba*, *yareta*, coal, or oil, is used. Anthracite

gas-producer engines have been employed, and Pelton water-wheels have been installed. However, at present, the majority of the large producers are using the Diesel engine, from which electric energy is generated. It is my belief, already stated, that hydro-electric equipments will prove the future source of power for Bolivian mining operations, and it would not be at all surprising to find my prediction of some four years ago regarding the electric smelting of tin ores borne out by the erection in Bolivia of smelters operated by hydro-electric plants.

FUEL. The scarcity of fuel forms one of the chief difficulties of Bolivian mining. Even if coal could be delivered to Coast points at a low figure, the railroad rates from the ports to the interior are so exorbitant that they have the effect of raising the cost of coal \$20 to \$30 per ton by the time it reaches Bolivian railroad points. Australian coal costs about \$12.50 per ton at Coast points. This prohibits the use of coal as a means for generating power. The Peruvian oilfields suggest a near-by source of fuel. However, it costs less to import California crude-oil than to buy the Peruvian product.

LABOR. Native Indian labor of both sexes is used in the mines and in the mills, while the majority of the superintendents and mine managers are Europeans. The wages of ordinary Indian labor vary from 40c. to \$2.40 per day, the average being about \$1. The Indians are natural miners and if the fast-days were not so frequent, these laborers would prove satisfactory. There is a scarcity of labor, however.

COSTS. Generalizations regarding working-costs are of little value, and my disinclination to publish more or less confidential information prevents me from giving detailed figures. Further, in view of the present unrest among Bolivian mine-owners caused by the discussion of the so-called 20% law, I do not care to be quoted as having stated the actual cost at any one locality. My observation of cost-sheets of mines in widely scattered localities and operating under diverse conditions shows that the total cost of mining, milling, freight, duties, commissions, insurance, etc., ranges from 14 to 38c. per pound of tin contained in the barilla laid down in Europe. This does not include the smelting charge; and it is to be remarked that only under exceptionally favorable conditions can tin ores be placed on the European markets at the low cost of 14c. per pound of metal. The average is considerably higher.

NICKEL-COPPER matte shipped from the Sudbury district of Ontario during 1916 is estimated to be worth \$28,000,000 before being refined, a large increase over previous years. The nickel is worth \$20,000,000 and the copper \$8,000,000. After refining in New Jersey the nickel should be worth \$30,000,000 and the copper \$12,000,000. Refineries may be built in Canada by the International Nickel Co.

Idaho's output of lead in pounds is about equal to Montana's annual output of copper, but the average price of lead is only about a third that of copper.

Engineering Education in the United States

By Charles S. Howe

ENGINEERING EDUCATION is an outgrowth of the idea that men may be prepared in a school for any trade or profession. This idea has arisen from time to time in the minds of some men engaged in various branches of work, but has been very slowly accepted as a general truth. In considering the application of this idea we must remember that a school is a place where something is taught and a teacher is a person who teaches something to one who does not know it. Engineering may have originated in military necessity or have come about through the overflowing of the Nile, but in either case some practice in the subject has in every country preceded systematic instruction. Without attempting to give a history of the progress of engineering, it may be said that the building of roads, bridges, and other structures was of necessity taken up by armies long before schools were established.

The history of the development of all professional schools has been practically the same. The first law-school in the United States was established in 1784. Previous to that, and even for many years after, the young man who desired to become a lawyer apprenticed himself to a practising attorney and acquired his whole knowledge of law from what he could learn in the office and in the courts. At the present time hardly anyone would think of studying law in this way. The opportunities in law-schools are so much greater than they can possibly be in a lawyer's office that the legal aspirant now attends the former, where he can get a diversity of knowledge utterly impossible to gain from one attorney. In like manner young men who desire to become physicians studied with a physician, were quizzed by him, and practised with him for a number of years until they were deemed worthy to practise by themselves. At the present time no young man studies medicine in this way. It is impossible for any one practitioner to give the young medical student all the things that he must have in order to pass the State medical examinations and to practise on his own account. This diversity of training, and especially the laboratory practice now necessary can only be obtained in a school.

Fifty years ago it was thought that engineering must be studied in a similar manner; that a boy must work with a civil engineer or with a mechanical engineer or go into a mine in order to learn anything about his profession. Today the great majority of students who study engineering do it at a technical school because through the breadth of the courses and the opportunities in the

laboratories they are able to secure a broad training that cannot possibly be obtained in any other way. Not long ago business men would have laughed at the idea of teaching business methods and principles in school, and yet today hundreds of young men in Wall Street offices are studying business in school and are taught by college professors.

Up to the year 1862, the schools in the United States where an engineering education could be obtained were few and had a limited number of students. Not many of these schools had a four years' course and the curricula were very meagre as compared with what they are now. Nearly if not quite all of the work was in the line of civil engineering. In 1862, Congress passed the Morrill Bill which provided for the "endowment, support, and maintenance of at least one college in each State where the object shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts." This was a wise and far-sighted measure. Up to that period few, if any, of the colleges in the United States required any science for entrance; most of them gave very little scientific instruction, and almost without exception there was no laboratory work in any science. A measure which, in spite of this practice on the part of the colleges, required instruction in agriculture and the mechanic arts, thus providing for strong courses in applied science, was almost revolutionary and in the light of recent events must be considered as dictated by the highest wisdom. By means of this measure the State universities then in existence established agricultural and engineering courses and many State universities have since been established with these courses as a part of the regular curriculum. The term "mechanic arts" has been interpreted in most cases to mean "engineering or scientific education."

The demand for men to originate methods and supervise construction, to apply science and natural laws to manufacturing, railroads, mines, and chemistry, was the impelling cause that led to the establishment of courses in engineering.

Previous to the Civil War our development along most of these lines had been comparatively slow and the schools then established seemed sufficient to meet the needs of the slowly growing industrial arts, but during and after the war progress was so great that methods of education and training which before had been sufficient became entirely inadequate and the introduction of these schools not only opened a new era in education, but also brought into the field of industry many men with such preliminary training that they could make rapid prog-

*Abstract of a paper read before the Cleveland Engineering Society and published in the proceedings of the Society in May 1916.

ness in the industries with which they were connected.

The growth of these institutions has been rapid. In 1862 there were but six of them in existence and the total number of students was not more than 300. At the present time there are over 100 engineering schools and the total number of students is about 25,000. Some of these schools are privately endowed and teach engineering only. Some are engineering departments in privately endowed universities and some are definite parts of State universities. The courses and methods of instruction in all of them are essentially the same and hence they may be discussed together.

The problems that these schools have had to meet have been new and difficult. They are professional schools, but their work has been much harder to organize than that of most such schools. Schools of law and of medicine take students either from the high-schools or from the colleges, but in either case they do not attempt to give a broad education nor to teach the subjects usually taught in college. They may, therefore, devote their whole time to the special subjects in which it is their province to give instruction. But the engineering schools are on an entirely different basis. The great majority of their students are high-school graduates, but before they can comprehend the professional subjects which they wish to learn, it is necessary to give them instruction in higher mathematics, English, chemistry, and physics, and in most cases it is deemed necessary to give instruction in at least one modern language. The time, then, devoted to purely professional work is not so long as in the case of other professional schools. It has been difficult to preserve a proper balance between subjects that are sometimes considered as purely cultural and those that are distinctly professional. In making up the curriculum it has been necessary to keep in mind what the graduate will be required to do, and the qualifications for success. Engineering education does not produce engineers. It merely gives to young men that thorough fundamental training which will enable them to become engineers after they have had a few years of practical experience.

An eminent engineer, who has been at the head of a great industrial establishment, has said that the engineer of today should be accurate in his calculations, thorough in his investigations, logical in his deductions, lucid and concise in his statements. He should have untiring energy and alert mind, an abundant initiative, and reasonable self-confidence. He should be absolutely honest in all his dealings, truthful in all his statements, loyal to his clients, faithful to his employer's interests, considerate of his subordinates, diplomatic in his negotiations, and tactful in all his relations. While the college cannot give a man all of these qualifications, it is evident that it can assist in the development of many of them and can show the student the necessity for all of them. To accomplish these results the student must learn certain things: he must learn where to find other things and he must learn to use in the best possible way both his present knowledge and that which he will here-

after obtain. It has been exceedingly difficult to determine just what things the student should learn.

One of the gravest problems that technical education has to face today is whether the student shall be given a broad general training or whether this training shall be limited and the courses highly specialized. Those who contend that a broad general course should be given believe that such a course is the proper foundation not only for that general culture that is so beneficial to every man for his own satisfaction and in his relations to others, but for all future intellectual progress. They believe that this broad foundation should be the basis of all engineering work and that the man who has it is able to take up any subject and rapidly become skilled in it whether he has studied it in college or not. They contend that it is far better to give this broad training with very little specialization than it is to cover a large number of subjects, which may be of special practical value, but for which a man is unprepared because of lack of the proper ground-work. It is particularly advantageous, the advocates of this method say, for a man to finish a general college course before entering a technical school. During his college course he learns how to study; he decides upon his future career; he trains himself in language, in mathematics, in English, which are especially advantageous to him in engineering studies; and his mind is developed to such an extent that he can meet the problems which will come up in the engineering school or in engineering practice, with far more ease and ability than can the student who has merely had the professional training.

On the other hand, the advocates of the specialized courses would give a moderate amount of the subjects named above and would then permit the student to specialize so that he might determine when in college whether he would become a sanitary engineer, a railroad engineer, a shop-superintendent, or an analytical chemist, etc. It is claimed by those who favor this method that specialization has reached such a point that a man, to succeed, must give his attention to one narrow branch of work—that the college is the place for him to study the theory of his specialty and to obtain so much laboratory practice that he will readily become expert in his branch after he leaves the institution. Our engineering schools are divided between these two theories. In a few of our universities the engineering work is a post graduate course, but in a great majority of our technical schools students are admitted directly from the high school. The future must decide whether those who first finish a college course and later take up the professional courses in engineering will succeed better in engineering practice than those who have had the more limited education.

As to the more prominent divisions of engineering education to be pursued there is general accord. These divisions are civil engineering, mechanical engineering, electrical engineering, mining engineering, and chemical engineering. A few institutions offer but one of these courses, while the majority of our colleges offer all of

them. Each course comprehends a number of subdivisions and every year sees an addition to this number. In the early days of engineering education, civil engineering was the only branch taught. Later the development in the manufacture of machine-tools and steam-engines necessitated courses in mechanical engineering. For some time after the application of electricity to practical things this subject was taught as a part of mechanical engineering, but within the past 25 years almost every institution offering engineering courses has provided a special course in electrical engineering. Mining engineering courses have always been divided into mining engineering and metallurgical engineering, while chemistry, which was formerly merely an analytical subject, has now united with engineering processes and developed into a chemical engineering course. It is an exceedingly difficult thing to decide what subjects shall be taught, for the number of them increases with great rapidity and if all are to be given the prominence which their advocates expect, our engineering courses will have to be extended from four to six or even eight years.

Laboratory work has always been an essential part of engineering education. Before 1865 hardly any American college gave laboratory work even in chemistry. From the first the engineering schools have insisted that practical application should accompany theory in every subject. The engineer's work is essentially practical—he must do things, and he cannot learn to do things by simply studying theory. The latter must be connected with practice so that the laws upon which theory is founded may be used to accomplish engineering results. At the present time every engineering school has extensive laboratories, not only in the science, some of which are the basis of engineering, but in the engineering subjects themselves. It is on account of the training which the student receives in the laboratory that he is able to apply natural laws and scientific methods to the work which he will take up as soon as he graduates. Perhaps in some institutions the laboratories are too extensive; perhaps too much detail is insisted upon in some branches, but the principle of the application of the theory is an essential one in engineering education and has been largely responsible for its rapid development and for the success of those who have pursued it.

But no matter how many subjects we teach, there are always some that cannot be taken up by any student. The student who has specialized in one subject in the engineering school may find himself pursuing an entirely different line of work after he graduates, or he may find that in his own specialty there are developments which were not known at the time when he was a student or for which he did not have sufficient time when he was within the college walls. It is evident, then, that every engineer, after he leaves the college, must use many things which he did not learn when in college. For this reason it becomes important to teach him where to find things he does not know. Engineering books, encyclopedias, the reports of societies, engineering magazines, all contain a

vast amount of material that may be of use to an engineer, and in fact, must be used by him from time to time in order to carry out the most recent practice of his profession. To a certain extent the use of this material is mentioned in the engineering school. It has always seemed to me, however, that this development has not reached that point which it should—for a student ought to learn where to find anything within the realm of knowledge. If he has not done so there is much which is known to some one but which is hidden from him. It is evident to every thinking person that the successful man must use what others have done and that college, which has taught the student where to find anything that he may need, has given him a most important part of his engineering training.

But knowledge, whether in the memory or hidden in books or periodical literature, is of no benefit to the engineer unless he has been taught how to use it. The most important thing which the engineering schools are trying to do is to teach the students to think; to see the connection between what they know or what they may find out, and the special problem which has come to them for solution; to determine not only how to do a thing, but to do it in the best way from an engineering standpoint; to do it in the way that will succeed commercially as well as scientifically. It is much easier to hear a man recite or to lecture to him than it is to teach him how to use the thing that is being presented. There are no general courses on thinking; there are no perfected rules of initiative; there are no known methods of teaching common sense. These things come to a student through his own study; from his own thought. He must be gifted with certain faculties of mind if he is to use to the greatest advantage those things which the engineering school presents to him. The school may help him to develop these faculties, and every course properly presented does assist in training them, but no professor, no laboratory, can create these faculties.

Engineering education means four years of discipline. In its highest development this is mental, moral, and physical. The mental discipline I have endeavored to describe; the moral discipline stands out in every recitation, in every laboratory course, in every instructor. If science and engineering teach anything they teach the student to look for the truth and to be satisfied with nothing else. They teach him to shun the shams, to have no pre-conceived notions, to look at both sides of every question, and to accept in his engineering work only that which can be proved. Such teaching as this strengthens the moral fibre in any character and reacts upon every phase of the student's life. Although sometimes unwritten, there is a code of professional ethics in every branch of engineering which the engineer must live up to if he is to be at peace with his fellow workers. Unfortunately we cannot enforce such a code of ethics by law as is done in some foreign countries, but the opinion of the profession at large has done much to prescribe honest practice as between engineers and between the engineer and his client.

Outcrops and the Prospector

By William H. Storms

A KNOWLEDGE of geology, and still more of mineralogy, is valuable to the prospector. It is strangely true, however, that some of the greatest mines of the world were discovered by men having knowledge of neither geology nor mineralogy, but there are also numerous instances where, had these men had even a rudimentary knowledge of the science they would have located more wisely, thereby saving much expensive litigation over mining rights.

What well-informed prospector today, having found gold at the mouth of Gold canyon, would be ten years in discovering the Comstock lode? And yet, this was the length of time that elapsed between the finding of gold in 1848 by Mormon campers near the present town of Dayton, and the discovery of the gold-bearing outcrop on Gold hill. The experience of the placer miners who worked in Six-Mile canyon was identical, for the Ophir outcrop was discovered at about the same time that the find was made on Gold hill, after ten years of placer operations in the gulches below the great lode. In these days the Comstock would have been discovered and located from end to end within a week after the finding of placer-gold and miles of territory on all sides of it would likewise have been claimed by wide-awake prospectors.

Again, it is unlikely that miners sluicing and getting good pay, but finding a heavy light-gray sand constantly filling the riffles and interfering with the saving of the gold, would be years in discovering that there was lead carbonate in the neighboring hills, as was the case at Leadville, in 1866. At that time the place was known as Oro City and the placers were highly profitable, but it was not until about 1876 that lead-silver ore was found on the slope of Carbonate hill. Soon after this the mines were extensively developed and produced prodigious amounts of silver and lead, but it was many years before the presence of oxidized ores of zinc was recognized. The same may be said of the discovery of zinc carbonate at Cerro Gordo, in California. It is not long since the miners near Nome, Alaska, threw away a large fortune in tungsten that was found in abundance in their sluices. The tungsten occurred as scheelite, in the form of pebbles and sand, and gave them not a little annoyance by packing in the riffles. Some of that ground may be reworked now to recover the tungsten ore, and at present prices it may pay well to do so. These are but a few of many similar instances, all of which go to show how essential an elementary knowledge of geology and mineralogy is to the prospector. In the case of the Comstock it was the necessary geological knowledge that was lacking; at the other localities cited, it was the failure to recognize common minerals.

The question naturally arises, can a prospector form a definite idea of the probable value of an undeveloped vein or deposit, from a mere inspection of the outcrop? In many cases the experienced prospector can; but what of the novice, what shall guide him in his search? He has taken up a novel occupation. He may have had no experience or instruction in mineralogy or geology, and yet, such men as these have discovered some of the world's greatest mines. This is known to be a fact, but men of the same calibre have located thousands of claims that were not worth the trouble it took to write the notice, or to even blaze the discovery-tree and scrawl thereon the notice of location.

Outcrops vary greatly in size and appearance. Some are great masses of heavily mineralized silicious rock, standing boldly above the surface, as at Broken hill; others form no striking topographic feature, as at Tonopah, and therefore attract little attention from the casual observer. Still others are small and obscure, but they may be rich. In some places the vein is mantled by a heavy gossan of iron and manganese oxides—black, ragged, and forbidding in aspect; in others the outcrops consist of large masses of quartz, gleaming white and usually worthless. Sometimes the outcrop is so nearly like the adjoining country-rock as to remain unnoticed, until discovered by accident. Some of the ore of the noted Yellow Aster mine, in Kern county, California, is to all appearances an ordinary granite-porphry, exactly like that which is worthless.

So varied are outcrops that an attempt to say which kind has proved to indicate the most valuable mines would probably fail. There are some kinds, however, that may usually be relied upon to supply a large amount of ore, though possibly too low in grade to be profitable. Still, this is only relative, for, by change in conditions, particularly in transportation facilities, the low-grade orebody of today may become the dividend-payer of tomorrow. There are numerous great and profitable mines being operated on a large scale that would be disastrous failures if worked in a small way. Examples of these are found in some of the great low-grade gold mines of Alaska, the copper mines of Bingham, Utah; Ely, Nevada; and Chino, New Mexico.

Outcrops distinguished by extensive iron mineralization are usually indicative of large masses of sulphide ore in depth. Many noted copper mines have a large iron-oxide outcrop, or gossan; for instance, the Iron Mountain and Mammoth mines of Shasta county, California. The former was originally worked for silver. Another example is furnished by the Ducktown mines of Tennessee, which were first worked for iron. Mount Morgan, in Queensland, Australia, though always a gold

mine, is now a large producer of copper, derived from bodies of sulphide ore found at depth. The outcrop of this mine was a silicious brown iron ore, rich in gold. The great copper-bearing lodes of Ely and of Chino contain very little copper at the surface that would attract the attention of a prospector unfamiliar with that type of deposit. The copper lodes of Butte, Montana, present merely rusty-looking outcrops of granite. In few places is there evidence at the surface of the great amount of copper lying in depth. Outcrops of this description would hardly be called 'gossan.' Numerous similar instances occurring in various parts of the world may be mentioned, but those mentioned are typical.

Silver and lead-silver mines are frequently distinguished by heavy outcrops of silicious black oxide of manganese. There were a number of such at Leadville, at or near the surface. What is known as the Rainbow lode, at Butte, on which are the Lexington, Alice, Moulton, Alagna Charta, and other noted silver mines, belongs to this class. Among the famous mines of this type are those at Broken Hill, in Australia. The Bunker Hill & Sullivan mine, in the Coeur d'Alene, Idaho, is another. It is said that the discoverer, a man named O'Rourke, had been following float up the hillside through thick brush and over fallen timber, when he came upon the huge outcrop, he was so astonished at its dimensions and great prospective wealth that he sat down on a log for half an hour or more to contemplate his discovery and decide what he had better do. He finally returned to his partner in camp without having even put up a notice, forgetting all about it in his excitement. This, as a general procedure, is not to be recommended, and the more valuable the property the more foolish would such neglect be. Every prospector should provide himself with copies of the Federal and local mining laws, and he should follow out every requirement of these laws with scrupulous exactness, for the more valuable his mine proves to be, the more necessary will it be to secure his title, and too often, with all the painstaking care he may exercise, the prospector will find certain forceful individuals who will endeavor to find some way to get hold of his find. In the early days gun-plays were of frequent occurrence over the discoveries of rich mines, and they are not wholly unknown today.

The outcrop of the Comstock lode at Virginia City and Gold Hill, Nevada, consists of a series of iron-stained projections of quartz running along the lower slopes of Mount Davidson. From Cedar hill on the north to Gold hill on the south, many of these veins along the foot-wall of the great lode still may be seen, resembling giant walls falling into decay. Near Gold hill there remain thousands of tons of low-grade gold ore outcropping in rough silicious masses. At Tonopah, on the west slope of Mount Oddie, may be seen the remnants of the once extensive hard silicious outcrop veins that first attracted the attention of Jim Butler, the lucky discoverer.

The Homestake mine in South Dakota covers some of the largest bodies of gold ore in the world, yet no bold outcrop marks these immense deposits, and never did.

The formation is hornblende schist, which in places near the surface is altered to chlorite schist. The hills are not abrupt, and the great lenses of ore at the time of the discovery did not look unlike the surrounding rock. All the ore in the mines, and the adjacent country-rock as well, was red—schist and quartz alike—by reason of the iron oxide derived from the oxidation of iron sulphides and partly from the iron minerals of the original rock. The discoverers were guided to the outcrop by the finding of gold in the gravel of the neighboring gulches tributary to Gold Run. There are numerous places in the Black Hills, in Arizona, in Nevada, in Southern California, and elsewhere, where similar formations appear—practically identical in appearance with the Homestake, yet most of them are without value.

The line of the great Mother lode of California is indicated by large lenses of white quartz, and still larger masses of ankerite, but for the most part, these outcrops are not valuable for their gold content, and the most prominent and productive mines, as a rule, have not had prominent quartz outcrops. Generally the richest ore-shoots on the Mother lode do not outcrop at the surface, but are found several hundred feet underground.

Large white outcrops of quartz are common, but ordinarily they are valueless. Near Custer peak, in the Black Hills, is a mass of quartz over 100 ft. wide and about 3000 ft. long. It looks like a huge snowdrift in the summer time, so white is it, but, as far as known, it is destitute of gold. It is called the Standing Horse, but whether so named by the Indians or the miners I do not know. Four miles south of Prescott, Arizona, is another big outcrop of white quartz, but it, like the other, is practically barren. It is known as Quartz mountain. These great masses of white quartz occur in many places, but few of them ever prove to be of value for gold or for anything else unless they are close to the railway, in which event they may have economic value for the making of glass or similar uses.

In the Lava Beds mining district, in San Bernardino county, California, about 30 miles east of Daggett, is a vein that would attract the attention of any prospector, experienced or otherwise. The locator of this great vein noticed its dark wall-like outcrop from a range of hills 20 miles away, while prospecting. Having found nothing encouraging where he had been searching, he decided to cross the intervening desert valley and investigate this, which to him seemed to answer to the descriptions he had read of the Great Wall of China. On nearer approach he found it to be a huge vein, and not a dike, as he had feared it might prove to be. Rising at its eastern end from the desert detritus, it extended for 8000 ft. without a break except where displaced for a few feet by dikes. It stood from 10 to 80 ft. above the surrounding surface and from 10 to 100 ft. in width. It was cut by two canyons to a depth of 800 ft. It is an immense vein and structurally a beautiful one, but the ore is mostly too low-grade to be profitable, though there are rich places here and there along its course. I have seen silver chloride ore from this vein that was worth

\$4000 per ton, but I also saw plenty that is not worth \$4 per ton. It also contains a little gold, lead, and copper. Westward it ends as abruptly as the side of a house, nor has its continuation—if it ever had one in that direction—ever been discovered. The country-rock of this vein is quartz-porphry.

The recent demand for industrial minerals has made desirable a knowledge of the mode of occurrence of manganese, chromic iron, magnesite, cinnabar, and the tungsten minerals; in fact, such knowledge is absolutely necessary to the prospector, if he hopes to discover deposits of these minerals; so I add further notes concerning them.

Not long ago I had occasion to inspect a property on which it was said a deposit of magnesite occurred. I visited the place and near the base of the hill found several small pieces of magnesite that seemed to be of fair quality. It was raining at the time, but I went up the hill and began to hunt for the magnesite deposit from which the small pieces had come. I searched for some time, but all I could find was some white calcite and a quantity of porcelain-like silica. I found no magnesite. The following day I visited another place where there was an outcrop of magnesite. Returning to town, and having nothing in particular to do, I decided to re-visit the place I had inspected the previous day, for I was not satisfied. I felt sure there was magnesite somewhere on the hill. I knew perfectly well that the detached pieces I had found had not come up hill—that somewhere

had it not been raining the first time I would have discovered the magnesite then. Magnesite generally occurs in serpentine, though it is occasionally associated with other rocks, as, for instance, the unusual deposits at Bissell, 20 miles east of Mojave, in Kern county, Cali-



OUTCROP OF QUARTZ AT PORCUPINE, ONTARIO.

formia, where the magnesite is interbedded with shales and thin beds of limestone.

As far as known, chromic iron always occurs in serpentine, there being no known exceptions to this anywhere in the world; therefore, the prospector will look in serpentine areas for chrome and not waste time in a fruitless search for this mineral in limestone, in granite, or anywhere else than in serpentine.

Cinnabar is easily recognized by its brilliant carmine color or streak, but metacinnabarite, which is essentially

the same as cinnabar, as far as composition goes, might easily be mistaken for an iron mineral of some kind. The presence of cinnabar or metacinnabarite may be detected by pulverizing the mineral and concentrating by panning. Place the concentrate in a beaker or in an ordinary tea-cup; add to it a little pulverized black oxide of manganese and then add hydrochloric acid and boil. After boiling several minutes, dilute with water and immerse in the solution a piece of perfectly clean copper. The copper may be prepared by first dipping in nitric acid. When the copper is dipped in the solution, if any mercury is present it will be precipitated on the surface of the copper. Meta-

cinnabarite is not a common mineral, and where it does occur there is usually some cinnabar with it. In California the ores of quicksilver generally are found at or near the contact of sandstone and serpentine. In fact, this applies to all of the great quicksilver mines of the world. At Almaden, in Spain; at Idria, in Austria; at New Almaden and New Idria, in California, and in China. However, it is interesting to know that ores of mercury also occur in limestone, as at Terlingua, in Texas, and in eruptive rocks, as in Nevada.

The prospector is particularly interested in finding



OUTCROP OF BULLFROG LODGE, IN NEVADA.

above, on that hillside, I would find magnesite if I looked carefully enough. This time I went farther up the slope, and noticing an outcrop of black rocks above me went up to them, whereupon I discovered that the outcrop was a body of magnesite from 4 to over 20 ft. wide. The black color was due to a covering of moss. Wherever the rock was broken by my hammer the snow-white magnesite appeared beneath. It was only the knowledge that the pieces I had found the day before must have come from some higher point that decided me to make a second visit to the place, with the result above stated. Probably

ores of tungsten at this time. The principal tungsten minerals are wolframite, manganese-iron tungstate; hübnerite, manganese tungstate; ferberite, iron tungstate; and scheelite, calcium tungstate. The first three minerals are grayish to brownish black. The last is white, yellowish, brownish, or sometimes grayish like bluish quartz. The general appearance of scheelite is that of feldspar. It usually presents numerous glistening faces, due to cleavage, which is absent in quartz. All of the tungsten minerals are noticeably heavy, and for this reason alone are likely to attract attention, if found in pieces the size of a walnut or larger. Of course, a handful of small pieces will have the same unusual weight when their mass is considered. Small pieces, though of the same gravity as larger ones, may fail to attract attention to this property of their remarkable density. Where tungsten ore occurs in disseminated grains it is more difficult to detect than where it is found in masses of considerable size. To determine the presence of the tungsten minerals the prospector can apply the same methods he uses to prospect for free gold; that is, by pulverizing the rock and panning. The concentrate then can be tested easily. Tungsten ores are generally found in highly silicious rocks, such as granite, granitoid schist, in rhyolite, at and near the contact of limestone and granitic veins. Tungsten minerals also occur in pegmatite veins, as in some of the New England states, and in the Black Hills. The most profitable tungsten mines in the Black Hills, however, are found associated with the sedimentary formation near the base of the Cambrian, where quartzites and limestones appear to replace the latter. These minerals are frequently associated in veins with the ores of gold, silver, lead, copper, and zinc, though sometimes they are scattered through the country-rocks.

When the rock suspected of containing tungsten has been pulverized and concentrated by panning, the concentrate may then be tested in a simple manner. Place the concentrate in a test-tube, a drinking-glass, or even in an ordinary tea-cup. Add a little hydrochloric acid; if tungsten be present, a yellow powder will form at the bottom of the glass, though this may be discolored somewhat by the presence of iron minerals. Add to this solution a little metallic zinc and the solution will turn blue if tungsten be present, the depth of the color being determined by the quantity of the yellow powder. If only a little, the color will be light-blue. If the amount is considerable, the color will be darker, even to deep indigo-blue. The addition of tin in place of zinc to the solution has a similar effect, producing the blue color. The prospector may have neither pure zinc nor tin, in which case he may substitute a piece of tin-foil, or even scrape a little tin from a bright tin-can, or chip off a little piece of solder. Either of these substitutes will produce the same color as zinc or tin.

When zinc is added to the solution containing the yellow powder, the color will be first blue; then port-wine color; then brown, but if the reduction takes place quickly, as it may with scheelite, the blue color may not

be observed at all, the first color seen being a reddish-lilac, which quickly becomes brown. If tin be used instead of zinc, the first color is blue, then lilac, then port-wine color, which slowly turns to brown. When using this test, allow the solution to stand several minutes after boiling, before adding the zinc or tin, in order that the formation of the yellow powder (the tri-oxide of tungsten) may be complete.

Sulphuric acid, one part acid to two or three parts water, may be used in place of hydrochloric acid with the same results, but the reactions will be slower. Nitric acid, also, will give the yellow powder, but no blue color is obtained by the addition of tin or zinc. Wolframite must be boiled much longer than scheelite, sometimes 10 to 20 minutes. Failure to give it plenty of time may result in no reaction being evident.

SILVER was discussed recently by Thomas W. Gibson, deputy minister of mines for Ontario. As printed in the *Canadian Mining Journal*, Mr. Gibson said in part: "The fact that the present intrinsic value of silver coins is much less than their face or denomination value does not appear to detract from their usefulness, which primarily depends upon their ability to pass from one person to another without demur. That a 50-cent coin, the silver in which is worth, at 75 cents per ounce, only 26 cents, or a 25-cent piece worth only 13 cents, circulates freely at face value is due not only to the coins being legal tender, but also to the circumstance that they were first made legal tender at a time when their nominal and real value much more nearly corresponded than they do now. Use and want have habituated people to the situation, and silver 'change' for a \$5 gold piece is given and accepted without thought, and in many cases doubtless without knowledge, that if the silver and gold were both melted the latter would sell for \$5, while the former would bring only \$2.60. The government that coins the silver and stamps it with its nominal value, profits by the difference. The profit of the British mint in 1913, when silver coinage to a nominal value of £1,934,404 was issued, was £726,926." That is, this amount was the excess of the face value of the coins over the price paid to the miner for the silver.

Production of explosives in the United States, excluding exports, during the calendar year 1915, according to figures that the Bureau of Mines has received from manufacturers, was 460,900,796 lb. (230,450 short tons), compared with 450,251,489 lb. (225,126 tons) in 1914. The report covers only the explosives used in coal and metal mining, railroad construction, and other industrial enterprises. The production for 1915 is segregated as follows: black powder, 197,722,300 lb.; high explosives other than permissible explosives, 235,828,587 lb.; and permissible explosives, 27,349,909 lb. These figures represent a decrease of 8,377,400 lb. of black powder; an increase of 17,374,616 lb. of high explosives, and 1,652,091 lb. of permissible explosives compared with figures for 1914.

Custom Smelters and Small Mines

By J. M. Turnbull

THE average prospector, mine-owner, or manager, and others interested in mining on a small scale, have usually vague ideas in regard to the operations of a smelter. Their ideas concerning the value of an ore are, as a rule, based on the gross returns. If the gross value of the ore, figured on a full assay at market prices of metals, is, say \$20, and the smelter treatment rate is \$5, one would at first sight expect to get a net of \$15, and when, instead, one gets \$8 or \$10, it is natural to feel that there is something wrong, and that all the deductions made by the smelter, which account for the difference, cover a large hidden profit—in fact that one has been robbed. If, however, one knew how these deductions were arrived at, and had an idea as to what deductions were reasonable and justified, and what were not, he would be in a better position to see what kind of a deal he was getting, and judge its fairness for himself.

In answer first to the broad question: Do smelters of custom ores make exorbitant charges, or rob the miner? I have no hesitation whatever in answering "No." In the great majority of cases where the charges seem excessive there is a good reason back of them. This is partly due to competition, and partly, in common with other large business, to the fact that in the long run it pays to be reasonably honest. In exceptional cases exorbitant charges may be made, but eventually they discourage production, on which the life of the smelter depends, and the modern policy is to encourage the producer with fair rates, and so build up a permanent business, in return for the large capital investment involved. While not usually guilty of robbery and extortion, smelters are in business to make a profit, and endeavor to sell to the best advantage. The small miner can hardly expect as good rates as put back in the steady producer, but by knowing something about the business he can often market his ore to better advantage, and get the best contract possible.

SMELTER PROFITS. The A. S. & R. Co., the so-called Trust, did a volume of business in 1915 amounting to \$225,000,000, in which their net profit was some \$13,000,000, or 5% on the turn-over. Of this, however, nearly \$1,000,000 was put back in the form of new construction for 1916. The year 1915 was a good year, and the profits do not look big compared with some of the 'war baby' stocks. The profits were very good, much better than in many former years, but they hardly look like extortion or robbery.

On over 4,000,000 tons the average net profit was

about \$2.25 per ton. In British Columbia our smelters are largely engaged in smelting ores from their own mines, and their total profits are from both mine and smelter, and the smelting profits are not separately given in annual reports. In the case of the Trail smelter, which treats the largest tonnage of custom ore in British Columbia, this represents from 12 to 15% of their total only. I happen to know positively, from my past connection with this smelter, that their rates are not extortionate on custom ores.

Having given the smelters a fairly good character, I shall now take up certain points in connection with their operations and charges in detail. While there is no big nigger in the fence, there are a few small niggers, a knowledge of whom may be of some benefit to you.

SETTLEMENT. Theoretically a smelter operates on the idea that he takes your ore, extracts the pure metals from it, and hands them back to you, charging you a fair price for the work of doing so. In practice this is found to be impossible. Each lot of ore cannot be smelted separately, and its contents kept separate. For economical smelting an average constant mixture must be maintained, so that before the ore ever sees the furnace it is mixed up with other ores, and since ores are received irregularly, some are smelted quickly and others may be delayed some time, in order to keep the furnace mixture reasonably constant. A dozen different ores may be in the furnace at once and the metal produced is merely an average; the average losses can be determined, but no one can tell what the exact loss is on any particular one of them. What the smelter does is to put each lot separately through the sampling-mill and assay the sample, determining the metal content by this assay. The losses can only be assumed in each case from the average loss on all the ores smelted together.

A smelter test on any lot of ore consists of an accurate sampling and assay. There can be no real smelter test on one lot. To ship a carload for a smelter test means therefore that you get an accurate sample, and the smelting quality of the ore is largely judged from the analysis made in the laboratory, long before the ore gets near the furnace. Since metal is produced by the smelter in one lot from many lots of ore, it is practically impossible to separate it into proportionate small lots and hand each mine back its proportion, nor could it be sold in this way to advantage, since metal-selling is a complicated business, based on large contracts, etc., so that the smelter is compelled to act as selling agent. Selling costs money; therefore the smelter always deducts a marketing charge from your ore in some form or other.

Extracting the metal from your ore and selling it takes on the average about three months; therefore, un-

*Summary of informal talk before the Vancouver Chamber of Mines, given by request, for information of prospectors and small mine owners, and published in the *Mining Engineering and Electrical Record*, at Vancouver.

less you wish to wait three months for your returns, the smelter is compelled to act as banker, and advance you the money on the basis of the assay. This means interest charges, which are also deducted from you in some form. The price of metals may vary greatly in three months, however, so that if the smelter pays you on the basis of the price at the time he receives the ore, he may make a profit or loss on the sale of metal three months later, according as the price goes up or down in the meantime.

This method of payment is known as 'spot' settlement. It is not desired by the smelter, since a slump usually occurs when metal prices are high, when everybody is shipping all he can and the smelter is overstocked with ores, so that the tendency is for the smelter to make a larger loss on the slump than his gain on the rising market. To place the risk of gain or loss on the mines, the smelter may make contracts on a three months' settlement, that is, pay 90% spot and adjust the balance on the price of metals three months after receipt, paying you in fact as near as possible on the basis of what he actually receives for the metal. By paying you spot, on a rising market, and switching to three-month basis before a slump, the smelter stands to make an extra profit. The miner's interest obviously calls him to do the opposite, if possible. It is a kind of guessing contest, and the best guesser wins. I need hardly say who is likely to be the best guesser, and the smelter is hardly likely to allow you to switch to your advantage when you please, so that you should not allow him to do so either, which you can accomplish by making a contract over a considerable period, choosing if possible which kind of settlement you prefer, if you can get it. The smelter has the advantage of a better knowledge of market conditions and of not being compelled to accept a settlement he does not desire, while the mine has the advantage of being able to ship heavily or lightly according to conditions on the usual contract. This is one small nigger in the fence, the advantage being rather on the side of the miner, if he knows the game.

TREATMENT CHARGES. In quoting you a treatment rate, the smelter makes various deductions, which are supposed to cover marketing costs, losses in smelting, and so on. Presumably these are the costs and losses actually incurred by the smelter in operation, acting as your agent, and do not theoretically leave any profit for the smelter, that is, from the deductions alone. In addition, a straight treatment charge is made, which presumably covers the actual cost of smelting plus profit. If the smelter makes an unusually low treatment charge, he probably makes up the difference by high deductions, and vice versa. A low treatment charge does not necessarily mean that you are getting your ore smelted cheaply.

In the meantime, what is a fair treatment charge? This depends on the ore, and can only be answered in general terms. On copper ores, with immense tonnages of easily smelted ore, the direct cost of smelting may be as low as \$1.25 per ton, as at Grand Forks. With high-grade concentrates it may run up to \$4, or even more.

On the general run of ordinary ores somewhat about \$3 would not be excessive. Adding one or two dollars for profit a charge of \$4 or \$5 is reasonable in most cases, provided an extra profit is not also made on excessive deductions.

On lead ores that require roasting, as most B. C. ores do, the direct cost of smelting, not including refining, may run as high as \$8 or even more, but it is even more difficult to average than on copper, depending on the grade of the ore, and treatment charge is often on a sliding scale varying from \$8 to \$12, which, including profit, is not excessive if the deductions are fair.

Ore as received at the smelter in railway-cars is first weighed, giving the gross weight, then in turn it goes through the sampling-mill, being crushed, run over samplers, etc., in the course of which it dries to some extent. The sample is taken, part of it is weighed and dried in an oven, and the percentage of moisture determined. From this and the gross weight the dry weight is calculated; the assay is made on the dried sample and payment is made on the dry weight, which is fair and accurate. In the sampling and handling, however, the ore dries somewhat and there is often a considerable loss in dust. To cover these losses the smelter sometimes makes a deduction of about $\frac{1}{2}\%$, which is called 'yard' loss. The loss is real, but just what it really amounts to is hard to determine—impossible, in fact. One must judge its fairness by circumstances. It is, however, not a dishonest deduction in principle—it is a question of amount.

MARKETING CHARGES. What is a fair marketing charge? This is rather a knotty question to answer. Let us see what marketing charges consist of. Refining either lead or copper is usually considered as part of the marketing. Copper refining probably costs about $\frac{1}{2}c.$ per lb. in the East, and somewhat higher in the West, depending on labor and electric-power costs largely, as well as the scale of operations, say, not over $\frac{3}{4}c.$ Freight from the West to New York would account for another $\frac{1}{2}$ to $\frac{3}{4}c.$ Three months interest brokerage and commissions bring the total up to $1\frac{1}{2}$ to $1\frac{3}{4}c.$ for the big fellows, while the smaller smelter might be out $3c.$ or even more. On custom ores the deduction is usually from 3 to $4c.$ per pound. In general, the smelter probably plays safe on this and makes from $\frac{1}{2}$ to $1c.$ per lb. equivalent to from 30 to $60c.$ per ton on a 3% ore. A high deduction on this account is all right if the treatment charge is low by a corresponding amount.

In the case of lead, refining is less costly, being a minimum of $0.2c.$ per pound under favorable conditions of cheap fuel and labor. In the West it might run up to $0.5c.$ Freight would be to the East, where the chief market is, another 0.5 or $0.6c.$, besides selling expenses. The Trail smelter deducts $1c.$ per lb. for marketing, on which it evidently makes no profit. American smelters usually deduct $1\frac{1}{2}$ to $1\frac{3}{4}c.$ on which, with better marketing conditions, they should make a considerable profit, and can make apparently low treatment charges on ore in consequence. There is a mutual tariff-wall between Canada and the U. S. on lead; hence marketing condi-

tions are somewhat artificial, whereas in copper there is free interchange. Lead ores as shipped usually contain from 25 to 70% lead, whereas copper ores run from 1 or 2% up to not over 10 or 15%, hence the marketing charge on lead usually figures out much higher per ton of ore, even though less per pound of metal. It therefore looks much worse than it is. In fact, it is surprising that miners will cheerfully pay 3c. per pound on copper, and yet make vigorous objection to 1c. per pound on lead, which is a much more favorable charge. The reason is probably because it looks worse per ton of ore. The difference is plain.

METAL DEDUCTIONS. Smelters usually make deductions from the metal assay to cover losses in smelting. In the case of copper, losses are chiefly in the slag, and partly mechanical, handling, flue-dust, etc. Slag in the furnace seems to hold a certain minimum amount of copper, varying to some extent with the grade of the ore. Considering all the operations, the loss seldom runs much below 0.3%, and may be considerably more on high-grade ores. We may take 0.3% as a fair average deduction on which the smelter is not making much, if any, profit. Except on high-grade ores, 20 to 30% copper or more, any deduction over about 0.3%, represents a profit for the smelter. In many cases it will be found that the smelter is making a deduction of 1 to 1.3%, usually with a low treatment charge to correspond, since few smelters would have the nerve to make this deduction and a full treatment charge as well.

The reason for making this high deduction is three-fold: First, 1.3% is an old standard deduction that has been adhered to, and the difference made up by reducing the treatment charges.

Second, a low treatment charge looks attractive, many miners scanning that more closely than the deductions; the treatment charge may even be zero, which looks very fine.

Third, the price of copper. The smelter is evidently making a profit of 1% copper, or 20 lb. At 12c. net per lb. the smelter is getting \$2.40 per ton of ore, and at 24c. it is getting \$4.80 per ton. Your treatment charge is automatically rising with the price of copper. Fine for the smelter on a rising market, and vice versa. On the 24c. price 0.3% deduction and \$4.80 treatment is equivalent to 1.3% deduction and zero treatment. In the latter case you are getting your ore treated for nothing, I don't think. The cathode price is ½c. less than electrolytic.

Lead deductions are on quite a different basis, chiefly because lead and lead compounds, unlike copper, are volatile at the usual furnace and roasting heats. Lead smelters make various rates. The Trail smelter pays 90% of the lead; that is it deducts 10% for losses, which losses mostly occur in smoke. Certain American smelters smelt Mexican lead ores in bond and are required to export the equivalent amount of lead metal. The U. S. Government therefore checks them up, and makes an allowance for losses in smelting and refining. In 1914 these were as follows: Balbach, New Jersey, 8.52%; Perth, Amboy, N. J., 22.32%; El Paso, Texas, 18.56%.

This is pretty good evidence. In the case of Trail, I know that the losses are over 10%, that is why they are spending so much money on Cottrell smoke-plants.

As a matter of fact the losses depend on the ores; they are least on pure ores. In Missouri they may be less than 5%, but on impure zinky ores as we have in Canada, in the West, 10% is a fair deduction—more than fair, in fact, in spite of the text-books, which tell you that the smelter saves 93 to 95% of the lead.

PENALTIES AND BONUSES. Lead furnace-slugs can carry about 6 or 7% zinc without much detriment. Above this point the zinc has two bad effects: first, it tends to carry silver into the slag; second, it tends to make the slag infusible and pasty, which results in slow furnace running, greater slag-losses, and difficulties in running, which add materially to the cost and trouble, of which there are plenty in lead smelting in any case, and cuts down capacity. This rapidly becomes worse as the zinc gets higher. With over 12 to 15% zinc it is next to impossible to run the furnace. A smelter that receives low zinc ores on the average can stand a few lots of high zinc without much detriment, and should not charge a high zinc penalty. Where the zinc in ores averages high anyway, extra lots of very high zinc are a serious matter and necessitate a high penalty, and even then they are not desired. The usual penalty is 25 to 50c. per unit (1%) on all zinc over 8 to 10%.

SILICA, IRON, AND LIME. In order to run a furnace properly the smelter must keep an even balance between silica on the one hand and iron and lime on the other. If he cannot get this balance in the available ores, he is compelled to make it with barren fluxes, such as quartz iron ores (free from sulphur, if possible) or limestone. Few smelters can get an even balance, or self-fluxing mixture, from ores only, and have to offer special inducements in order to attract the kind of ore they need, and make it possible to ship low-grade ores of the needed class, by offering a bonus on the kind of material they require. At the same time they usually charge a penalty on ores of opposite character.

The proper method is to have the penalty and bonus equal and opposite, usually 5 to 10c. per unit, payable or chargeable on the excess of one side over the other, that is, silica excess over iron plus lime or vice versa. One or two little jokers may occur here. Where the silica excess is penalized, the contract sometimes forgets to mention the lime and refers to iron only, so that too much penalty is paid. Sometimes the penalty is made larger than the bonus, and all the silica, say, is charged with penalty, and all the iron and lime credited with bonus. In the case of an ore running even there should be neither penalty nor bonus, but by this joker, if there is, say, 30% of each, you pay 30 by say 10c. penalty and get only 30 by say 7c. bonus, a difference in favor of the smelter of 90 cents per ton.

Instead of silica, the contract may specify 'insoluble,' which means merely that portion of the ore insoluble in acids, which may be considerably higher than the true silica in some cases.

Gold-Scheelite Ore in New Zealand

By C. W. Gudgeon

*In Otago, in the South Island, gold and scheelite ores occur at Macrae's and Glenoreby in Waihemo and Lake counties, respectively. At the former centre is the Golden Point mine, developed by adits. In it are three parallel lodes, running conformable with the altered zone strata, and separated 15 and 25 ft. They are much faulted and are difficult to follow. Careful timbering is necessary. The top lode, No. 1, 3 to 4 ft. thick, is low in gold and tungsten, but has odd pockets of rich ore. No. 2 is 3 to 6 ft. thick, contains 0.5 to 1 oz. gold, and is highly impregnated with scheelite, with pockets of almost pure mineral. No. 3 is small and of no importance. The gangue is quartz; the country-rock is mica schist, lying horizontal. Driving is cheap owing to the soft schist, as low as \$1.44 per foot for a 4½ by 6-ft. drift. Underground work costs \$1.86 per ton.

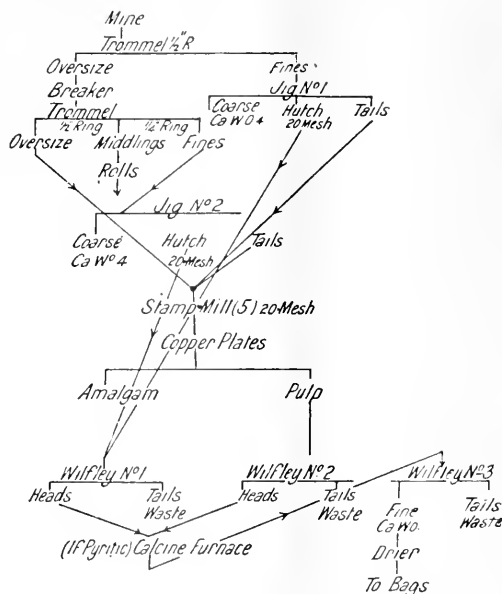
Ore treatment consists of hand-grading the best ore to 60-65% WO_3 , which is shipped. The lower-grade ore is crushed at the rate of 30 tons per day through 30-mesh by ten 900-lb. stamps. Copper plates save the coarse gold. The pulp is classified and passed over Wilfley tables, which concentrate out the scheelite. Sand is cyanided in vats by percolation; the slime is stored. Amalgamation saves 46% and cyanidation 36% of the gold. Increased depth of mining gives scheelite associated with iron pyrite. The concentrate contains 30 to 40% CaWO_4 (scheelite), 50 to 55% pyrite, 10% silica, and 2½ oz. gold, and is equal to 0.5 to 1% of the ore milled.

Concentrate treatment consists of drying the product in a cylindrical outside-driven roasting-furnace. During this process the calcined concentrate is elevated and dropped 8 ft., with free access to the air. Roasting is done as far as the magnetic sulphide stage. The concentrate is next separated electrically, making an iron-gold and a scheelite product. During this separation 15% of the scheelite and 21% of the silica is detected over with the magnetic iron, while running on high amperage. This iron product is submitted to re-treatment and re-roasting, giving a clean iron product containing 5 to 6 oz. gold per ton, and 73.1% CaWO_4 , equal to 61.2% WO_3 . Concentrate high in silica is reduced to 10% or under, before separation, by jigging. Total treatment charges are \$1.38 per ton of ore milled. All costs were \$3.53 per ton.

Five miles north-west of the Golden Point mine is the Highlay, which was worked-out in 1913. The coarse hard ore was crushed by five 800-lb. stamps, while a 5-ft. Huntington mill reduced the finer and softer material. These machines were followed by copper plates. Fine vanners for the soft and Wilfley tables for the hard ore. Sand was cyanided, and slime run to waste. For many years the mill treated 1000 tons per month, averaging

0.28% WO_3 and 42c. gold per ton. Costs were 90c. for all departments.

On Mt. Juda, 240 miles north-west of Dunedin, the Glenoreby Scheelite Mine Co. is operating. The lode is in metamorphic schist similar to those at Macrae's, but the schist is harder and more crystalline. The mine is opened by drifts from the surface, along the pitch of the orebody. The gangue is a dense quartz, and has associated with it gold, scheelite, iron, and arsenical pyrite. The scheelite occurs in the ore-channel in distinct layers, irregularly



FLOW-SHEET OF GLENOREBY GOLD-SCHEELITE MILL, NEW ZEALAND.

spaced, through the barren lode-matter. The lenses are high in scheelite, and are very pyritic in the sulphide zone.

The present scheme of treatment, shown in the accompanying flow-sheet, gives good results. As little crushing is given as possible, as the scheelite is so friable. If pyritic, the concentrate is roasted and re-dressed to 70% WO_3 . As the iron tailing is low in gold it is discarded. From 5400 tons of ore the recovery averaged 7.09% WO_3 and 45c. gold per ton. Costs total \$5.52 per ton.

The following is a reliable assay of pyritic-scheelite concentrate: Take 10 grams of material and grind in an agate mortar. Digest in aqua regia and evaporate to dryness three times. Take-up with hot H_2O and boil. Filter. Wash with hot H_2O till free of all chlorides. Wash with hot dilute HCl . Dissolve the CaWO_4 with hot ammonia. Evaporate to dryness. Ignite, and estimate as WO_3 (tungstic oxide).

THE SAN FRANCISCO MINT in June received 201,019 oz. of gold and 63,857 oz. of silver. Gold sold amounted to 52,214 oz. \$24,000 in nickels and \$2700 in pennies were coined. The vaults contain \$370,628,914.36.

*Abstract from Bulletin 21 of Aust. I. M. E.

The Demand for Quicksilver

The domestic quicksilver industry has continued active during the first six months of 1916, and the average price for the period has been about double the exceptionally high figure for the entire year 1915. Figures just compiled by the U. S. Geological Survey show that the total production of quicksilver in the United States in 1915 was 21,033 flasks of 75 lb. each, having a marketed value of \$1,826,912, or an average of \$86.86 per flask. Of this output 14,283 flasks, selling for \$1,174,881 came from California, and the remainder almost entirely from Texas and Nevada. The actual average sales value for the whole country exceeded the average market value in San Francisco—which was \$85.80 for the year. In 1914 the domestic output was 16,548 flasks, valued at \$811,680, and therefore the production for 1915 showed an increase of over 27% in quantity and 125% in value.

The increased domestic demand for quicksilver in the last 18 months has been due mainly to war requirements for fulminate and drugs. Early in 1915 domestic stocks began to be drawn upon and production became more active, but as foreign embargoes left the field clear and domestic output was unable to meet the rapidly increasing call for the metal, prices continued to rise throughout the year and into the early months of 1916, the high mark of \$300 per flask being passed in February. Naturally every mine and prospect became of interest. The reaction set-in, however, as the high prices drew out quicksilver supplies in Mexico and elsewhere that had been originally purchased for amalgamation of gold and silver ores, and finally as the British government permitted exports to America under certain limitations. The average monthly domestic price in San Francisco, which had climbed from \$51.90 in January 1915, to \$295 in February 1916, dropped to \$219 in March, \$141.60 in April, \$90 in May, and about \$72 in June. The market remains steady and in general highly profitable, and as domestic prices have dropped below London quotations, exports rather than imports of the metal may be expected. There is probably no great quantity of metal stored, and consumption is undoubtedly abnormally large.

Favorable markets have brought out great activity in search for new prospects, and discoveries near Morton, Washington, and Beagle, Oregon, in 1916 have led to some development and construction of reduction plants. Also in the Skull Valley deposits, Arizona, referred to many years ago by W. P. Blake, and at Black Pine, Idaho, some activity is reported. Many old furnaces have been repaired or enlarged in California, Nevada, and Texas, old workings have been re-opened, and new discoveries have been developed.

It is likely that the exceptionally high prices of the last few months have led to gouging and robbing many mines of their best ore, and the average tenor of the ore worked by the larger mines during the first half of 1916 may prove considerably below that of previous years. Moreover, some mines have undoubtedly passed their maxi-

mum productivity. These conditions are probably offset to some extent by the fact that more furnace capacity is now working on quicksilver ores than at any previous time in the history of the industry. On the whole, the mid-year outlook is for an output in 1916 fully equal to that of 1915.

The Big Three

There are three copper producers on the American continent which can each show a net earning capacity of \$40,000,000 or better on a sustained 25-cent copper market: Anaconda, Kennecott, and Utah Copper. In point of volume of output and profit these are America's 'Big Three' in the copper industry. No others are in the same class.

Measured by production, Anaconda, of course, stands at the top of the list, its annual output now running at the rate of 340,000,000 lb. Utah is second with 190,000,000 lb., and Kennecott third with 216,000,000 lb., but of this latter amount, 48,000,000 is represented by the company's 25% ownership in Utah Copper. Excluding the Utah duplication referred to, these premier producers combined are earning at the rate of no less than \$124,000,000 from 700,000,000 lb. of annual output. This production represents over 50% of the total smelter output of the United States in 1915—1,365,500,000 lb. Carrying the comparison a step farther, it will be found that Anaconda, Utah Copper, and Kennecott are earning almost three times the total profits realized from the 1914 production of the whole country, including imports. In that year electrolytic copper averaged 13.30c. for the 12 months and the average cost of production was easily 9½c. per lb. At the outside, therefore, the profits could not have exceeded four cents per pound on 1,150,000,000 lb., or \$46,000,000.

That three properties in 1916 should be able to earn three times what all the mines on the North American continent could produce two years ago, testifies not only to the bigness of each of these three units, but to the sensational profits that are made when copper sells for 25 cents.

There are no other copper mining concerns which can approach the class of the Big Three. Phelps, Dodge & Co. comes fourth with 140,000,000-lb. output when its Mexican property, the Moctezuma, producing 22,000,000 lb., is in commission. Next would come Inspiration with 120,000,000 lb.—*Boston News Bureau.*

THE BUTTE & SUPERIOR mine in Montana mined 591,562 tons of ore in the year ending June 30, 1916. This ore was worth \$31.27 per ton, giving a gross value of \$20,271,949. This makes the Butte & Superior one of the great mines of the world. For comparison the Utah Copper Company's income from copper produced in 1915 was \$26,235,331. The Elba Ore mine, which is adjacent to the Butte & Superior, mined 209,752 tons of zinc ore worth \$18.52 per ton, in the year ended June 30. The net profit was \$495,757.

CONCENTRATES

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

CHISELS are made from steel containing 0.75 to 0.85% carbon, which is about the same proportion of carbon as is contained in drill-steel.

THE FLOTATION PROCESS at Braden, Chile, is saving 80% of the copper from 4000 tons of ore per day. As 10% of the copper minerals is oxidized, this is equivalent to 90% of the copper sulphides.

MEXICAN silver dollars purchased in San Francisco in 1857 by a traveler going to the Orient, where such coins were in regular circulation, cost \$1.30 each in American gold, the price of one ounce of silver at that time.

MERCURY FULMINATE, used in detonators and floating mines, explodes at a pressure of 28,750 kilograms per square centimetre, or 204.45 tons per square inch. Nitroglycerine explodes with less than half of this force.

CYANIDE CONSUMPTION at the Great Boulder mine, Kalgoorlie, Western Australia, where roasting and fine grinding is practised, is 0.96 lb. per ton; mercury loss in the pans is 0.11 oz. per ton. The cost of treatment is \$2.48 per ton.

A BLAST may be delayed as much as an hour by the fuse being bent and the spark retarded. It is not well when loading a blast to bend fuse at a sharp angle; nor is it well to approach a charge of unfired explosive, the fuses of which have been lit within an hour.

WOUNDS should not be treated with mercuric chloride dressings, if iodine has been applied. The consequence would be the formation of mercuric iodide, which is strongly irritating. To remove mercuric iodide, wash the wound with a 10% solution of potassium iodide.

CEMENT-SETTING in drill-holes in mineralized underground waters is not thoroughly understood, and there is considerable dispute about it. One system is to analyze the water and add certain chemicals to neutralize acidity. Many successful well-cementers declare that minerals in the water have nothing to do with it.

MINE-TIMBER in the Passagem mine of the Ouro Preto company in Brazil is treated with lime mixed with a solution of zinc sulphate, a waste product from the cyanide works. This liquor has a preservative effect on the wood. White ants attack some mine-timber near the surface.

CEMENT MORTAR is used on the Canal Zone to plug cavities in trees that might otherwise collect water and serve as breeding places for mosquitoes. A 1:4 mixture is employed for ordinary-sized cavities, while the volume

of mortar needed for large ones is reduced by using pieces of rock in the aggregate. In the city of Panama over 4000 cavities in 1600 trees have been plugged.

METAL is being used to a greater extent than formerly for farm buildings. Barns with steel frames, or covered with galvanized-steel sheeting and equipped with metal ventilating systems are becoming popular. Other farm structures that are being made at least partly of metal include corn-cribs, garages, hog-cots, and silos.

LEAD-PLATED STEEL is being substituted for zinc-plated and nickel-plated metal. It is particularly useful for protection against the corrosion caused by acid and fumes. A new process of lead-plating has been recently perfected by a firm in Cleveland. The lead-plate is said to be cheaper than the zinc-plate or nickel-plate.

NAILS driven in wood that is exposed to alternate wetting and drying are likely to work out. The wetting swells the wood and moves the nail, which does not return to its original position when the timber dries. It is for this reason that timber structures bolted together and exposed to weather require screwing up at intervals.

IN TREATING GOLD ORE worth \$10.11 per ton last year, the Hollinger mill at Porcupine, Ontario, used 0.574 lb. of cyanide, 1.896 lb. of lime, 0.467 lb. of zinc, 0.0032 lb. of acid, and 0.0021 lb. of lead acetate per ton milled. The pregnant cyanide solution averaged \$5.074 per ton. Tailing contained 40 cents per ton. The cost of treatment was \$1 per ton.

SAWMILLS in the United States number over 48,000, and their output of waste in the form of saw-dust, shavings, slabs, and other wood refuse is estimated as 36,000,000 cords per year. Perhaps one-half of this so-called waste product is not strictly speaking wasted, but serves a useful purpose as fuel under the boilers, according to the Forest Service. Much of the remaining 18,000,000 cords not only serves no useful purpose, but in most cases is a source of inconvenience and danger, and costs the mill both time and money.

IMPURITIES in spelter are chiefly lead, iron, and cadmium; traces of arsenic, antimony, sulphur, tin, and copper also are found. In some special brands of high-grade American spelter, the lead does not exceed 0.02%, and iron 0.01 to 0.02%. In good ordinary brands, lead may be 0.4 to 1%, and iron 0.03 to 0.05%. In spelter intended for rolling, a small proportion of lead is desirable, and up to 1% it has no injurious effect on the ductility of the metal. But for spelter used in making cart-ridges, where the mechanical treatment is severe, the content of lead should be as low as possible, not exceeding 0.1%. Iron makes spelter hard and brittle, showing perhaps as grey specks on a fresh fracture. Not more than 0.05% iron is allowed in spelter intended for brass. Cadmium, often associated with zinc, is not harmful up to 0.5% in spelter used for brass.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

FLAT RIVER, MISSOURI

INTERESTING NOTES FROM A GREAT LEAD CENTRE.

The lead district of south-eastern Missouri is very prosperous this summer. The high price for the metal is stimulating production, and a record output is being made. Employees are receiving the highest wages ever paid here, another 10% bonus having been added in April. This gives labor an increase of 30% above that of 18 months ago. According to the local bankers most of the men are saving their money. A rather severe lesson was taught during the panic of 1907; wages were high then and money was spent freely. The entire district is under local option now, which has also aided in a larger saving by the men.

There have been one or two strikes among certain elements of the men. On May 1 the foreigners at the Federal Lead and Doe Run Lead companies went on strike for higher wages and fewer cars to be shoveled per man-shift. They were out for over a week, resulting in the close-down of the Federal mill and consequent idleness of several hundred men as well as themselves. The strike did not spread, and on May 10 they returned to work at the same wage-rate.

At a meeting of the shareholders of the Doe Run Lead Co., held on May 11, it was decided to consolidate with the St. Joseph Lead Co., and to dissolve the Doe Run corporation. A petition to this effect was filed with the Circuit Court, and will be acted on during the October term of the Court.

Construction of the new Federal mill is proceeding rapidly. The building is of concrete and steel on a hill-side, and is practically complete. This is the only mill in the district to use a steep sloping site. An interesting test has been conducted for some time in the Federal mill between Deister-Overstrom, Butchart, and Wilfley tables. The last-named has long been the standard in the district, but during the last year a great deal of interest has been taken in treating large quantities of ore on a single table. As a result, the St. Joseph and Doe Run companies were licensed by Mr. Butchart to fit their Wilfley tables with his rifle system. The Desloge Lead and the St. Louis Smelting & Refining companies are installing Butchart tables in their mills, replacing Wilfley and Overstrom tables. The Federal mill will use tables of each make.

A great deal of option and development drilling is being done in the district. The Baker Lead Co. is drilling the Barber-Turley-Cole tract, north-west of Bonne Terre. Some option drilling has also been done near Des Arc in Iron county. The St. Joseph Lead Co. is shipping slag from an old pile at Bonne Terre to its smelter at Herculaneum for re-treatment. This slag was made 40 years ago, and is high enough in lead and matte to make reduction profitable.

The old silver mines in Madison county are proving to be a surprise for the district. It is reported on reliable authority that a large amount of tungsten is available. The ore-bearing vein has been traced for 1½ miles and is from 2 to 6 ft. wide. In addition to tungsten the ore contains lead, zinc, and silver. A stamp-mill is being erected with tables and a flotation plant.

The Fredericktown district is being opened. The North American Mines Co. will start operation shortly. It has been announced in the local press that the Mine La Motte Co. will build a railroad from its property to the Mississippi river, a distance of 30 miles. It will join the 17 miles of road now

operated by the company. The way has been surveyed, with low grades. The estimated cost of road, stations, switches, etc., will be not over \$500,000. With the rolling-stock now owned, the new equipment will not cost more than \$150,000. This will be of great benefit to the company, as it is now paying \$12,000 per month freight and switching charges, for about 200 tons per day, covering coal and lead concentrate. In addition



MAP SHOWING SITUATION OF MINING DISTRICTS IN SOUTH-EAST MISSOURI.

tion to the present mines, deposits of clay, limestone, granite, and sand become available for market. In connection with the railroad, the company plans to put a barge line in operation on the Mississippi river, to be connected with the railroad by modern wharf facilities. The saving in freight alone will pay the maintenance and operating cost of the railway and barge line.

WASHINGTON, D. C.

SALE OF OIL-LAND BEFORE CONGRESS

Gifford Pinchot has come out strongly against the Phelan bill which disposes of 3,000,000 acres of Government oil-lands in California and Wyoming, withdrawn by ex-President Taft to protect them from monopoly and to await further legislation. The prospect is that there will be a lively fight over the bill. It is familiarly known as the Leasing Bill, and has been reported to the Senate from out the Committee on Public Lands as a substitute for the Ferris leasing bill of the House

of Representatives, which included coal as well as oil and mineral lands. The Phelan bill, strangely enough, excluded coal lands from the operations of the act, an announcement stating that the coal lands would be attended to in a later bill. The additional new feature was the disposition of the California and Wyoming oil-lands mentioned. The conservationists are excited over the prospects of the bill, and Mr. Pinchot announces that he has arrived in Washington for good to combat its passage. The Attorney-General of the United States and the Secretary of the Navy have given testimony in opposition to the oil-land provisions in the Phelan bill, and Mr. Pinchot takes comfort in this, but the Secretary of the Interior consents to the bill in toto.

WRANGELL, ALASKA

NOTES ON THE COUNTRY ADJACENT.

Essentially a fishing town, the town of Wrangell derives but little from the mining industry. It is an outfitting point for some prospectors, but very little in the way of actual mining has ever been done in the district. Several groups of claims near-by are undergoing development. Wrangell, as the second oldest settlement in Alaska, was the supply centre for one of the oldest Northern mining districts, the Cassiar. The city was first a trading-post, established early in the 19th century by the Russian-American Fur Co.; then, with the development of the district a Hudson's Bay post was established. After the Cassiar strike in 1873, an American garrison was stationed there.

J. G. Galvin, formerly of Nome, has taken a bond on the Ground Hog properties, which are on the mainland 15 miles from Wrangell. The claims are owned by W. D. Grant, S. C. Shurick, Brigham Grant, and Donald Sinclair. The price for the six claims is stated to be \$50,000. Galvin plans to do some development work soon. But little more than surface work has been done so far. The properties are 3000 feet above sea-level. Test shipments three years ago showed 15 tons to average \$46.80 per ton, it is claimed.

News from the McDames Creek country of the Cassiar is that H. Godfrey and associates, who have bonded a number of placer claims there, are working with a crew of men.

The most promising mining news is the discovery of new silver-lead prospects on the Stikine river, in the Devils Elbow district. The prospects caused quite a flurry, all of the residents of Telegraph Creek stampeding down-river when the first news leaked out. S. I. Silverman, J. E. Chilberg, and others are interested in the properties, having taken a lease and option on some of the holdings of Dixon, Bodell, and associates. The claims are located at Glenora, 110 miles from Wrangell and 40 miles below Telegraph creek, on the British Columbia side of the boundary. The properties are on the east side of the Stikine. The main drawback to the rapid development of the district near Glenora is the difficulty of navigation and the consequent high cost of supplies. Assay-values of samples from the Glenora are said to vary from \$38 to \$298 per ton. A company, the A. B. C. Metals Co., has been organized to finance these prospects.

The Stikine Mining Co. also has a crew of men at work on a newly discovered vein in the same district.

The last boat to make the trip up the Stikine took a number of prospectors to the Glenora district. Sixteen claims were staked and recorded in the Wrangell district last year, according to the files of U. S. Recorder Thomas. A Crown grant has been obtained on a group of 14 claims on the Iskut river, a tributary to the Stikine, by P. C. McCormick, C. M. Coulter, Alex. Vreath, E. S. Busby, George M. Whitney, Bruno Greif, John Maloney, and F. E. Bronson. The claims show chalcopryite.

At the Surf Inlet mine of the Tonopah Belmont company on Princess Royal island, construction work is making good progress in connecting the mine with tidewater.

TORONTO, ONTARIO

PORCUPINE, KIRKLAND LAKE, SESEKINIKIA, AND COBALT NEWS.

A valuation of the McIntyre, McIntyre Extension, and Jupiter properties is being made by C. H. Poirier of the Vipond, and M. W. Summerhayes of the Porcupine Crown, to obtain a basis for the proposed merger of the companies.—The Newray is preparing to resume active development on a large scale and is letting contracts for 30,000 ft. of diamond-drilling.—The Dome Lake has cut a 20-ft. vein on the 300-ft. level, the gold-content of which when first opened was \$9 per ton. It has been developed for 50 ft., with considerable improvement in grade.—Exploration carried on at the Dome Extension, under the option given to the Dome Mines, has given encouraging results. A diamond-drill hole put down 300 ft. east of the Dome property has encountered 75 ft. of good ore.—At the West Dome the shaft is down 325 ft. in ore yielding high assays. A 51-ft. vein has also been cut by diamond-drilling at a depth of 330 feet.

Mining in the Kirkland Lake district is active. The Tough Oakes is shipping between \$80,000 and \$100,000 of gold per month from the treatment of about 125 tons daily, a considerable proportion of which consists of tailing from the old amalgamation mill. Rich ore is being extracted from the 400-ft. level of No. 6 vein. Twenty-six drills are in operation, but only one of the large compressors can be operated owing to lack of power. With the completion of the power transmission-line from Cobalt, which is expected early in November, the production of the Tough Oakes and other mines of the district will be largely increased.—Rich ore has been found on the 300-ft. level of the Lake Shore.—The Wright-Hargraves, adjoining the Tough Oakes, which has two veins on the surface showing free gold, is being opened.

The Malouf properties in the Seseकिनика district, comprising three claims that were under option to Buffalo interests last year, are to be developed. John Papassimakes, who has taken a prominent part in the development of Boston Creek, has purchased a half-interest, after sampling had yielded satisfactory results. Five veins have been uncovered carrying free gold or telluride.

The vein recently discovered at 700 ft. on the Crown Reserve is opening well, yielding good milling ore and considerable high-grade across a foot of vein-matter. Another vein, 6 in. wide; cuts across it at right angles.—A contact has been let by the People's Mining Co. for the sinking of the shaft from the present level at 318 ft. to the contact, the distance being estimated at 250 ft.—The Adanac has found native silver in the vein on the west winze at 315 ft. together with patches of high grade. The vein is 14 in. wide.—The Trethewey is again on the shipping list, and the Hudson Bay lately reopened will make a shipment shortly.—The Cobalt Gem Mining Co. is being wound-up.—The Quaker City, south of the Gifford, is being reopened. The shaft, which is down 200 ft., has been unwatered and will be sunk deeper.

Gold output of the Dome in June was \$179,000 from 36,700 tons of ore, an average of \$4.88 per ton. Costs were \$2.62 per ton.

At a depth of 900 ft., a diamond-drill from the 500-ft. level of the McIntyre passed through 22 ft. of \$36 ore. A station has been cut at 1000 feet.

During June the Nipissing's output from 112 tons of high and 6380 tons of low-grade ore was \$294,660.

In the issue of July 8 it was stated that the Porcupine Vipond profit in 1915 was \$193,919; this was the total expense, the profit being \$31,136.

As the outcome of several meetings held by miners at Cobalt, it appears most likely that arbitration will be sought before any strike is attempted. In fact, the local union has given notice that it will apply for a conciliation and investigation board and it has definitely gone on record to the effect that the men will not strike until such board has been refused.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

On the Government railroad the Alaskan Engineering Commission is employing 2500 men, who receive a total of \$150,000 per month. On June 24 Congress at Washington appropriated \$6,000,000 for continuing construction work on the line. On the same date at Anchorage a suit was started in the District Court, whereby J. E. and F. L. Ballaine seek to recover \$450,000 for alleged damages sustained through a suit brought against them by the Alaska Northern Railway Co., in which the latter corporation sought to recover the Seward town-site and thus placed a cloud upon the title of the property at a time when its value reached a high point. The case was thrashed out in the Federal Court, and after a lengthy and spectacular trial, resulted in Judge Brown rendering a decision which gave the Ballaines title to their town-site. Since then lot-values at Seward have taken a downward slump, and the Ballaines feel that their financial loss, as the result of this litigation, has been nearly \$500,000. While the suit to recover damages is against the Alaska Northern Railway Co., the Alaskan Engineering Commission, through the purchase of this road, has fallen heir to it, although in no way a party to the transaction which deprived the Ballaines of any of their rights. This case may defer the payment of \$650,000 to the Alaska Northern Railway Co., and postpone the sale of lots at Seward. The military appropriation bill for \$500,000 also passed Congress. This means many improved roads, and \$350,000 will be spent between Valdez and Fairbanks.

The steamer *Burlington* will sail from Seattle on July 25 with 3000 tons of rails and other steel for the Government railroad to be delivered at St. Michael, thence to be conveyed up the Yukon and Tanana rivers to Nenana. The liner *Victoria* will sail for St. Michael on the same day with supplies to be similarly shipped from St. Michael to Nenana.

Preparations are being made to ship additional equipment to Alaska for the Alaskan Engineering Commission from the stock of surplus and obsolete equipment left over from construction of the Panama Canal, two ship-loads of which have already been sent, according to the *Canal Record*, published at Balboa. Arrangements for transportation have not been made, and the local representatives of steamship lines have been asked to keep the matter in mind and advise the Canal authorities if any of their vessels calling at Balboa would be interested in the shipment. Arrangements are to be made with the Alaskan Engineering Commission. The equipment will probably be ready for shipment about the first of September and will consist of 7 narrow-gauge locomotives, two 75-ton steam-shovels, four standard locomotives of 5-ft. gauge, and 50 Lidgerwood flat-cars. The heaviest lifts among the knocked-down parts are the locomotive boilers, weighing 15 tons each, and the steam-shovel car-bodies, weighing 14 tons each. The total weight of the shipment will be approximately 3000 tons. The equipment is being crated at Balboa by the Mechanical Division. If the shipment is to be delivered at Cook inlet, Alaska, this season it will have to leave Balboa by October 1 in order to reach port before the close of navigation. Seward, the other port at which it may be delivered, is open all the year.

KNIK

(Special Correspondence).—A trip through the Willow Creek district, with a side trip to the mouth of Moose creek, where

a contractor is getting out coal for the Alaska Railroad Commission, revealed the following points.

The season has been an extremely backward one, and all operators have been greatly handicapped by the snow on the mountains and hard freighting conditions. This spring the Willow Creek Mines, which operates the Gold Bullion mine on the divide between Willow and Craigie creeks, has installed an additional 5 stamps in its plant making a total of 12 stamps. The new ones weigh 850 lb. each, but will be probably increased to 1050 lb. to conform with the rest of the equipment. A new pipe-line is also being laid that will supply water-power under a 400-ft. head.

L. S. Robe, superintendent of the Independence Gold Mines Co., is installing a 5½-ft. Denver mill at the property on Fishhook creek.

The Mable Milling, Mining & Power Co. is installing a small Denver mill at its property on Archangel creek. The mill, which is approximately 1200 ft. below the mine, will be connected by a 3500-ft. aerial tram, having only one tower between terminals.

R. G. Doherty, who has a contract to supply the Railroad Commission with 2000 tons of coal, has opened a small mine on the west bank of Moose creek, about 1½ miles above the right-of-way, and is grading for a track down the creek. A 255-ft. drift has been put in on a 5-ft. coal seam with a counter gangway 15 ft. above, from which the brasts will be turned off. The bed is 5 ft. thick, strikes south-west, and dips about 50° south-east. The coal is a lignite and rather dirty, but a fair product can be secured with careful hand-sorting. Both walls are sandstone.

Knik, June 21.

The Talkeetna Mining Co. recently filed articles of incorporation. It has a capital of \$1,000,000, with headquarters at Anchorage. The company owns four lode claims in the Knik district. F. B. Wiseman of Anchorage is the Alaska agent.

The Alaska Anthracite Railroad Co., with a capital of \$500,000, has been formed by Henry Hewitt, Jr., James Campbell, and Clark E. Davis. The company will construct a railroad from Controller bay to the Bering River coalfields.

ARIZONA

The State Tax Commission has valued the producing mines of Arizona at \$172,731,914, an increase of \$54,795,910 over that of the previous year. The Inspiration is \$19,000,000 and the United Verde Extension \$5,500,281 more. These are new producers. Other gains are \$5,000,000 by the Copper Queen, \$9,000,000 by the United Verde, \$5,000,000 by Ray Con., \$1,000,000 by Arizona Copper, and \$9,000,000 by Calumet & Arizona. The status of counties is as follows: Cochise \$67,807,915; Gila, \$41,738,692; Yavapai, \$26,166,763; Pinal, \$16,312,249; Greenlee, \$15,778,941; Mohave, \$3,128,987; Pima, \$1,161,539; Santa Cruz, \$215,826; and Yuma, \$119,762.

Owners of mines containing a mixture of vanadinite and wulfenite and crocoite have had considerable trouble marketing the same, owing to the inability to separate the vanadium and molybdenum content. Either was undesirable in the other. It is now possible to separate these minerals, and more money is being paid for low-grade ore than was formerly paid for clean high-grade concentrate. Moreover, gold and lead are also paid for, which was not done formerly. There are a great many deposits of such ores in Arizona, whose owners

have been unable to market them. If they will communicate with Charles F. Willis, director of the State Bureau of Mines, Tucson, they will be advised where such ores may be sold.

COCUINE COUNTY

The June output of Shattuck-Arizona was 1,446,080 lb. of copper, 61,889 lb. of lead, 24,636 oz. of silver, and 367 oz. of gold.

MARICOPA COUNTY

To develop 11 claims in the Cunningham Pass district, 8 miles north-east of Wenden, J. Burson of Phoenix, A. W. Snyder of Globe, and others have formed the Wenden Copper Co., with a capital of \$100,000. Some good copper-gold ore has been shipped. Pumping machinery is to be ordered.

MOHAVE COUNTY

The recent sale of Black Range shares to E. McNeal & Co. of Chicago amounted to \$100,000, payments to be at the rate of \$4000 monthly. A new 2-compartment shaft is to be sunk in place of the old incline opening. Some good ore was opened by this shaft. A 60-hp. Western hoist is in use. The mine is considered one of the promising properties of Oatman.

CALIFORNIA

AMADOR COUNTY

The Plymouth Consolidated reports as follows for June:

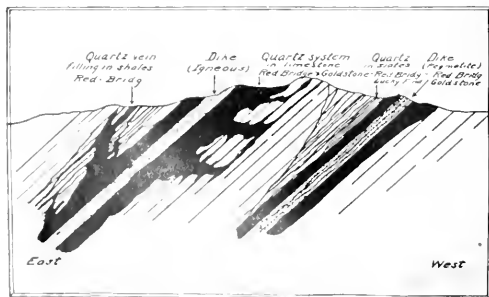
Ore crushed, tons	11,400
Value	\$56,685
Working expense	\$28,000
Development charge	\$ 7,321
Surplus	\$21,364
Other expenditure	\$15,525

GLENN COUNTY

According to news from Willows a gold-bearing lode has been unearthed by A. W. Roucroft between two deposits of manganese, along the road that connects the Alder Springs and San Hedrin roads.

SAN BERNARDINO COUNTY

A shipment of 30 tons of \$200 ore has been sent to Salt Lake City by the Goldstone Mining Co. of Goldstone, the new district. In the June issue of the *Mining and Oil Bulletin* of



SECTION OF GOLDSTONE DISTRICT, CALIFORNIA.

the Chamber of Mines and Oil of Los Angeles, this district is described by A. E. Rau. The general altitude is 3500 ft. The accompanying section shows the ore deposition.

NEVADA COUNTY

Machinery is arriving at the Columbia and Ocean Star mines near Ormonde, including a 200-hp. generator to supply power for both. A 20-stamp mill is to be built at the Ocean Star. E. C. Klinker is in charge.

PLACER COUNTY

The Adventure gold mine of R. L. Turner of Colfax, has

been bonded by Salt Lake City people, who are to erect a small concentrating mill. The property is in Shirt Tail canyon of the Iowa Hill district.

PLUMAS COUNTY

It is expected that the new 100-ton mill of the Walker company will be completed early in August, so will the aerial tram. Recent diamond-drilling shows 56 ft. of 12% copper ore. Reserves are estimated at 183,000 tons, averaging 7%. Concentrate will be hauled to the Western Pacific line at Portola, thence to Salt Lake City for smelting.

COLORADO

BOULDER COUNTY

The tungsten situation at Boulder is as follows, according to the *Daily Mining Record*: W. G. Blake, a Denver buyer for the Latrobe Steel Co. at Pittsburg, has just shipped 10 tons of high-grade concentrate to the company by express, in a sealed car. In spite of dullness in the tungsten market, not one of the numerous mill projects under construction throughout the Boulder district has been abandoned. The Rare Metals Co. at Rollinsville has its plant in operation, and is buying large quantities of low-grade ore at the mill. The Degge-Clark mill is practically completed, and will begin operations within the next two weeks. The Vasco plant at Stevens will also be in operation before August 1. J. Gillingham Hibbs of the Red Sign properties in Boulder canyon states that the 25-ton mill of his company will be ready for operation by August 1. Several small plants, including the Montgomery mill on the Lord Byron tract, and the Grimm mill at Duncan are now in operation. In spite of the present dullness in the tungsten market, a spirit of optimism as to the future prevails at most of the local mining offices. One of the large buyers who has been inactive for months has received definite instructions to begin purchasing within 10 days, and he expects the other buyers to follow his example.

LAKE COUNTY (LEADVILLE)

Water in the Wolfstone shaft last week was only 20 ft. above the 950-ft. level, or bottom.—Enlarging of the Penrose shaft-station for the new motor and pump is complete. Cleaning-out upper levels is under way.

The Valley adit in Prospect mountain has further opened the large body of low-grade oxidized iron ore, containing pockets of shipping ore.

Four new turncres are under construction at the Western Zinc Oxide Co.'s plant. Plenty of carbonate ore is available.

SAN JUAN COUNTY

Ore and concentrate shipments from the Silverton district in June totaled 118 cars.

IDAHO

OWYHEE COUNTY

In a report on the new Denning gold and silver district, 45 miles by way of Oreana from Murphy, terminus of a branch of the Oregon Short Line, the Rowland Corporations of Nampa say that the county is a vast basin of low sweeping foot-hills, hemmed in to the north by the Silver City range and the Jarbridge mountains to the south, the Owyhees to the east. Alternating formations seem to occur in rapid order, giving away, however, to a preponderance of feldspathic granite. In some portions diorite dikes have intruded the granite. Some prospects are good. Parties going into the district should provide themselves with food and blankets. There are only two small tents and one small cabin in the camp. The Duval ranch, two miles below, is the only likely place to obtain supplies of any kind.

SHOSHONE COUNTY (COEUR D'ALENE)

On July 25 the Success company of Nine-Mile pays 3c. per share, equal to \$15,000. The total for 1916 is \$345,000, and \$1,919,000 to date.

The National Copper Co. at Mullan has closed its mine and mill on account of the low value of the ore.

The Stewart company has increased its capital from \$1,250,000 to \$3,000,000, in order to acquire other properties. Two in Nevada and three in Idaho are being considered.

A rapid increase in mining activity is reported from the Pine Creek region. Developments in the Constitution and Douglas zinc mines continue to be extremely favorable. The Highland-Surprise mill is producing 25 tons of concentrate daily. The Nevada-Stewart, Big It, Big Eight, and Nabob all report promising results.

MICHIGAN

THE COPPER COUNTRY

Objection is being made to the tonnage tax on copper, which has been proposed by the Federal government on the ground that copper is a munition of war. Homer A. Guck argues that a tax on copper, once on the books at Washington, would be retained permanently, while the tax on other munitions would automatically cease when the war in Europe is over. This would mean a permanent addition to the cost of producing copper. It is reported that the bill has been drawn by a man who knows so little of copper mining that he presumed the smelters buy the ore from the mines and then make exorbitant profits from the sale of the metal to European countries at war. Furthermore the large consumption of copper for peaceful purposes at home has been overlooked.

The Calumet & Hecla reports as follows for May, in pounds:

Mines	May	5 months
Ahmeeek	2,070,551	9,180,272
Allouez	953,069	4,215,323
Calumet & Hecla	6,865,907	30,939,745
Centennial	231,879	1,052,778
Isle Royale	1,128,401	4,896,952
La Salle	123,592	563,238
Osceola	1,775,222	8,219,725
Superior	331,432	1,472,341
Tamarack	620,314	2,931,094
White Pine	446,607	1,888,024

MISSOURI

JOPLIN DISTRICT

Ore prices at Joplin last week were lower. According to local information operators are unable to determine whether the weakening in the market which has steadily taken place during the last month is indicative of a return to before-the-war schedules, or whether the present market fluctuations and general instability merely precede a heavy buying movement on the part of Eastern consumers, which will result in a rise in prices. There is scant reason to believe the first theory to be correct, indications being all in the direction of a strengthening of the market and increased consumption. Many local operators claim that the operation of their properties is impossible on less than \$70 ore, and that a further decrease of prices means the closing down of a number of mines. At present, but little effect has been noticed in the output, which was 5969 tons of blende, 32 tons of calamine, and 577 tons of lead, averaging \$70, \$44, \$73 per ton, respectively. The total value was \$464,025, making \$20,939,066 for the year to July 8.

A 350-ton mill is planned for the Dr. Carl Mining Co., P. Demerath, manager, south of Galena.—A 300-ton mill is being erected at the Mary C. mine at Prosperity.

MONTANA

MISSOULA COUNTY

(Special Correspondence.)—There is marked activity in mining in the Cataract district, and prospects of a successful year seem assured. The Crystal Copper Mining Co., with head offices at Boston, is operating its mine on Cataract creek, 8 miles by wagon-road north of Basin. The company has opened

a promising vein at the 200-ft. level, and is now driving an adit to intersect the lode at the 400-ft. level. This is expected to be done by August 1. The president, John A. Allen, and managing director, Walter H. Wood, expect shortly to examine the work.

The Uncle Sam group of claims operated by Butte capital, is shipping ore to the Helena smelter. The property is on Cataract creek, four miles from Basin.

The Sims and Klondike mines, P. J. Manning, manager, are employing a few men opening the old 1000-ft. adit, and intend driving a 280-ft. cross-cut to connect with the Klondike shaft. Work is progressing satisfactorily, and shipments will be made in the near future. The head office of the company is at Boulder, Montana.

The Ruby & Columbia Mines Co. of Boston, has recently acquired the Sunset claims, situated on the outskirts of the town of Basin. Mining operations here have been delayed by heavy snow-fall this winter, but with the arrival of M. A. House, the general manager of the company, from Boston, development undoubtedly will be greatly accelerated.

Basin, June 28.

SILVERBOW COUNTY (Butte)

During June, Butte & Superior treated 52,600 tons of ore, yielding 15,200,000 lb. of zinc and 310,000 oz. of silver, also 540 tons of lead concentrate. The recovery was 94%. On July 11 the B. & S. tailing-dam near Meaderville broke away, inundating the north end of the suburb.

East Butte's June output was 1,629,560 lb. of copper and 41,503 oz. silver, against 1,517,000 lb. in May.

For the Butte & Bacoan \$264,000 has been subscribed. After paying debts there will be \$180,000 for resumption of work. A steam or electric hoist is to be ordered.

In the first 3 months of 1916 the Tuolumne company made a profit of \$42,939, from 10,310 tons of ore shipped. Its operations continue at the Main Range and Colusa-Leonard Extension.

At the Butte & Zenith the shaft is down 830 ft. Thirty men are working. Cross-cutting will be started at 1000-ft. depth.

Unwatering of the Butte-Detroit has been done to a depth of 950 ft., and should be completed to the bottom this week. The shaft is in good condition.

It is probable that the Northern Pacific Railroad will construct a spur to the Tropic, Main Range, Colusa-Leonard, and Butte & London, about 6000 ft. in all.

Financial problems of the Butte-Duluth company are still complex, and the receiver is trying to get together all interests. Debts amount to \$875,000.

According to the assessment report for taxation, the North Butte Mining Co. during the 12 months ended June 1, showed the following results:

	1916	1915	1914
Ore mined, tons	195,275	262,615	463,437
Yield	\$ 5,106,252	\$2,583,071	\$5,929,372
Mining cost	2,079,431	1,163,963	1,831,839
Transportation	61,154	31,548	46,494
Treatment	1,733,274	923,536	1,784,152
Total cost	3,873,912	2,219,331	3,726,365
Net profit	\$ 1,229,339	\$363,739	\$1,291,006

The Anaconda Copper Mining Co.'s report showed the following:

	1916	1915	1914
Ore mined, tons	4,346,061	3,311,188	4,714,673
Gross proceeds	\$59,334,085	\$29,908,184	\$29,164,094
Mining cost	19,166,854	13,391,552	17,816,795
Cost of transportation	1,234,773	620,551	1,105,758
Cost of reduction	10,092,566	6,752,895	8,957,896
Cost of marketing	1,469,581	2,391,714	3,379,478
Total cost	31,959,204	23,157,715	30,859,426
Net proceeds	\$14,363,881	\$6,750,439	\$8,613,741

*Includes \$8,715,428 spent for improvements.

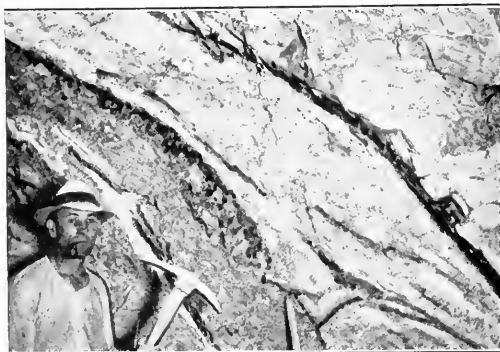
NEVADA

ESMERALDA COUNTY

In hitherto unprospected ground, 250 ft. from the Velvet shaft of the Jumbo Extension, and at a depth of 770 ft., \$10 to \$15 ore has been opened on the foot-wall side of the vein-matter. Also at 900 ft. a raise has cut good ore.

HUMBOLDT COUNTY

The north drift on the 1700-ft. level in the Seven Troughs Coalition is now yielding 8 in. of \$700 ore. Since first cut in the main winze, the north drift has opened this shoot for 25 ft., and an equal distance to the south, where although good quartz, is showing, the value is not as high. The new level



GOLD ORE IN THE SEVEN TROUGHS COALITION MINE.

is designated as the 1700 ft. A new direct-drive compressor of 395-cu. ft. capacity from the Chicago Pneumatic Tool Co., just received at the mine, will shortly be in place. This will practically double the air supply.

(Special Correspondence.)—A thorough sampling of the old Tascorora Mines' dumps is being made on behalf of an Eastern syndicate. The main dumps are from the old Grand Prize, Independence, and Navajo properties, and contain thousands of tons of ore averaging around \$5 per ton in gold and silver, mostly the latter metal. A crusher has been installed and shallow holes are being sunk in the dumps to facilitate general sampling. Arrangements have been made to work the mines on a broad scale.

The new mill at the Kennedy mine, near Kennedy, has been placed in commission. Mine developments have been proceeding for several weeks and a fair quantity of good ore is available for the plant. L. St. D. Rolance is general manager, and S. L. Berry is superintendent.

The lower shaft at the Wolverine copper mine, near Winnemucca, is down 100 ft. Work has been suspended pending installation of machinery to take care of water encountered. The upper shaft is down 50 ft. on an orebody 2 to 5 ft. wide, containing over 15% copper, with some gold and silver. M. Endregg is superintendent.

Suit has been filed against the Lincoln Hill Mining & Milling Co. of Rochester by the First National bank of Lovelock, to recover on a promissory note for \$917.35, with interest, \$250 costs, and attorney's fees.

The Hatch Leasing Co. is erecting a mill to treat ore from its lease on the Buckskin National mine, at National. Large quantities of gold ore of excellent grade are stated to be ready for extraction.

The rise of silver has instilled new life into the Golconda area. Several properties are shipping, and re-opening of many old mines is reported. From the Bull Con. Caroline two cars

of ore averaging 5 to 15% copper are shipped weekly. S. B. Kasper is managing owner.

Winnemucca, June 30.

LANDER COUNTY

Unwatering of the Glasgow & Western copper mine in Copper canyon, in the Battle Mountain district, has been started. Water-level is at 440 ft.; the shaft is 590 ft. deep. F. Sommer Schmidt is in charge.

LYON COUNTY

During June the Nevada-Douglas company shipped 22 cars of ore to Utah, worth \$51,040. In May the output was 16 tons (18 cars) netting \$2320 per car. Shipments in 5 months totaled 1951 tons, containing 479,990 lb. of copper, valued at \$87,561 net. Ore treated locally at the leaching plant is not included.

STOREY COUNTY

The Sutro tunnel at the Comstock is of great value to present operations in the Ophir, Mexican, Union, and other mines on the lode.

OKLAHOMA

OTTAWA COUNTY

The new Netta mill of the Eagle-Picher Lead Co. in the Cardin zinc-lead district is to have many improvements over other plants on similar ore. The crushing department for one-half includes one 18-in. breaker, one set of 42-in. and two sets of 36-in. rolls, two revolving screens and one 24-in. elevator, all with a capacity of 40 tons an hour. The jig equipment at the Netta consists of two 42 by 48 roughers of six cells each; one chat-rougher, 36 by 42, and one 7-cell cleaner. The chat-rougher will take the chats directly from the rougher-jigs, and is between them. The jigs are built high and there is a special arrangement for taking care of surplus water. The sludge-plant will occupy a good-sized building a short distance east of the mill, and will be unusually complete. It will house 22 Arbuthnot tables, which will be operated by a 50-hp. motor and will also have an Eccleson ball-mill, which already has been installed, and is in the middle of the sludge-room and about 8 ft. lower than the tables. This mill pulverizes the middling from the tables.

OREGON

The Oregon Bureau of Mines and Geology at Corvallis, has resumed publication of its monthly 'Mineral Resources of Oregon,' the last one being issued in December, 1914. The May number of 114 pages deals with some little-known scenic pleasure places in the Cascade range, by Ira A. Williams. The number is well illustrated, and contains a good deal of interest to mining men.

JACKSON COUNTY

On July 10 an election was held at Medford to decide whether the people approved of the Bullis contract for construction of a railway to the Blue Ledge mine. The voting was 1009 for and 366 against the proposal, a win for those in favor.

SOUTH DAKOTA

LAWRENCE COUNTY

At Lead on July 1 the first first-aid contest in the Black Hills was held. The seven teams were composed of Homestake employees, who worked hard to win the \$350 in prizes donated by the company.

The Ofer company in the Bald Mountain district is sending 100 tons of ore daily to the Mogul mill at Terry.

UTAH

BEAVER COUNTY

Renewed activity is reported from Fortuna.

At Newhouse the Utah Leasing Co., treating the Cactus tail-

ing dump by flotation, is to double its capacity to 800 tons daily. V. P. Strange is general manager.

In the Star district the Master Key company has been financed for development.

JUAR COUNTY (TINTIC)

On July 25 the Iron Blossom company pays 10c. per share, equal to \$100,000.

The Tintic Milling Co. has levied an assessment of 4c. per share, due August 4. With this the mill is to be increased from 100 to 300 tons daily.

SALT LAKE COUNTY

On August 10 the South Hecla company, shipping 50 tons of ore daily from the Cottonwoods, pays its initial dividend, of 15c. per share, or \$29,450.

The Cardiff company has 5 caterpillar-tractors and 60 trailers carrying ore from Big Cottonwood. The output is soon to be 300 tons daily.

SUMMIT COUNTY

Good progress is being made in erection of the new electrolytic zinc plant of the Judge Mining & Smelting Co., according to the general manager, George W. Lambourne to the Salt Lake Tribune. When the new plant is in operation it will produce 15 tons per day of the highest grade spelter. In doing this it will treat between 30 and 40 tons of high-grade zinc concentrate per day, supplied by the present mill. The concentrate will be put into solution and the metal will be deposited from the solution on aluminum cathodes, circular in form and revolving at a slow speed while immersed in the solution. The electric current will be employed to deposit the zinc in the form of sheets of spelter on the aluminum cathodes. The use of revolving cathodes is a departure from present methods, and is said to be a decided improvement. As far as is known it will be employed for the first time at the Judge plant. The spelter will be produced at a very low cost. The mine is at present shipping a small tonnage of zinc concentrate which is being stored until the new plant is in operation.

UTAH COUNTY

A deposit of manganese containing 50.39% metal, without impurities, has been opened on the Birch Springs ranch in Lucerne valley, near Manilla, by A. S. Brown and J. D. Wines.

WASHINGTON

STEVENS COUNTY

The Columbia Copper Co., capitalized at 1,000,000 shares at \$1 each, has been organized by Spokane men to take over and operate the holdings of the old Highgrade Mining Co. in the Deer Trail district. C. M. Carroll is president, Alex Robinson is vice-president and general manager, Oscar Olson is secretary-treasurer, and T. J. Vaughan Rhys is consulting engineer. The purchase price of the group is \$100,000, payments extending over a period of 10 years. This is a property on which large sums were expended years ago. A smelter costing \$114,000 was erected, but was never of any use. Some good machinery is available.

CANADA

BRITISH COLUMBIA

Some attention is being given by American mining men to the Erie gold-silver district, 30 miles from Nelson. Promising mines are the Arlington, Second Relief and Keystone. There are deposits of many minerals in different parts of the region, the metals appearing in combination as copper-gold, gold and silver, and lead-silver-zinc. All the natural facilities for mining operations are at hand. There is unlimited water-power that can be harnessed at small cost, and an abundance of timber for all purposes. Capital is necessary for exploitation.

Profits of the Standard Silver Lead company in May were \$38,436, a decrease on account of less ore shipments. Lead returned \$61,616, and zinc, \$18,260. The balance is \$59,373.

The Rambler Cariboo's June profit was \$11,000 from lead alone.

The Jackson Bell Zinc Mines Co. of Kaslo is being fully re-organized at Spokane by C. E. Caldwell and others. Shipments of 400 tons monthly are soon to be removed.

The Delta mine on Rocher De Boule mountain, near New Hazelton, has been purchased for \$50,000 by M. T. Watts and associates of Edmonton, Alberta, according to P. J. Jennings, president of the Spokane-Rocher De Boule Mining & Copper Co., who recently returned to Spokane from the district. The first payment is said to have been paid already to B. Thompson and B. Hallihan, the two prospectors who located the property recently. Work has been started on the 6000-ft. adit through Rocher De Boule mountain to open at depth the veins of the Rocher De Boule mine. In the upper workings ore now is being extracted at the rate of 100 to 130 tons daily, and regular shipments to the Tacoma smelter are being maintained. The ore averages 10% copper, and it is said that development and exploration have disclosed bodies that warrant the expense of driving the long adit.

YUKON

According to William Sime, territorial assayer at Whitehorse, there were 1242 samples received for assay, while 1573 assays or quantitative estimations were made. Of the former, 389 came from Whitehorse district, 197 from Dawson, 184 from Mayo, 156 from Wheaton, 50 from Conrad, and 12 from Atlin. Assays made included 1041 for gold and silver, 337 for copper, 102 for lead, 26 for platinum, and 23 for antimony, with several for zinc, tin, nickel, tungsten, and molybdenum. In the Whitehorse district considerable activity in copper mining is evident, four copper companies are to ship ore to the smelter, namely, the Pueblo, Grafton, Copper King, and War Eagle. Of these the Pueblo will be worked on the most extensive scale. This group was closed down shortly after the outbreak of war, but has lately been re-organized under a new company, and at present the shafts, which were allowed to fill with water, are being unwatered, and shipping of the ore will be started as soon as possible. It is the intention of the company to ship an average of about 300 tons of ore daily and employ from 200 to 300 men. The Grafton copper mine has been shipping ore steadily from July 1, 1915. During that period over 5000 tons has been sent to the smelter, averaging 7% copper and about \$3 in gold and silver.

In the Wheaton River district, outside parties have bonded six of the best antimony properties, and are getting ready to ship at least 100 tons of ore per month. This deposit is said to be extensive. On the Buffalo Hump group of gold and silver mines, in the same district, local parties have taken a two years' working bond on the ground, and will shortly commence operations preparatory to shipping.

In the Conrad district steps are also being taken to open some of the Windy Arm properties.

In the Dawson district, the Bear Creek Mining Co. intends working its quartz properties on a comparatively large scale this summer. The company intends to erect a modern 10-stamp mill, which is at present in Whitehorse waiting transportation. The company has also received rock-drills, air-compressors, electric motors, etc., which will be put to work as soon as possible. Considerable work has already been done on the property.

In the Mayo district, the Silver King mine has been hauling ore all winter to Mayo landing, for shipment outside.

The future for ore-mining in the Yukon territory has never looked brighter than at the present time, and particularly so for the southern end, where everything points to this being a banner year.

THE METAL MARKET

METAL PRICES

San Francisco, July 18.

Antimony, cents per pound	15
Electrolytic copper, cents per pound	28.50
Pig lead, cents per pound	7.00-7.75
Platinum: soft metal, per ounce	\$65
Platinum: hard metal, 10% iridium, per ounce	\$69
Quicksilver: per flask of 75 lb.	\$83
Spelter, cents per pound	12
Tin, cents per pound	40
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, July 18.

Antimony: 50% product, per unit (1% or 20 lb.)	\$1.00
Chromite: 40% and over, f.o.b. cars California, per ton	13.00-14.00
Manganese: 50% product, f.o.b. cars California, ton	12.00-20.00
Magnetite: crude, per ton	7.00-9.00
Molybdenum: 50% and over, per pound	0.60-1.15
Tungsten: 60% WO ₃ , per unit	25.00-35.00

EASTERN METAL MARKET

(By wire from New York.)

July 18.—Copper is dull and easy; lead is also dull and weak, spelter consumers are now interested.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
July 12	61.87
" 13	62.87
" 14	62.62
" 15	61.87
" 16 Sunday	62.87
" 17	62.87
" 18	62.37

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 57.58	48.85	56.76	July 54.90	47.52	...
Feb. 57.53	48.45	56.74	Aug. 54.35	47.11	...
Mch. 58.01	50.61	57.89	Sept. 53.75	48.77	...
Apr. 58.52	50.25	64.37	Oct. 51.12	49.40	...
May 58.21	49.87	74.27	Nov. 49.12	51.88	...
June 56.43	49.03	65.04	Dec. 49.27	55.34	...

The market has been somewhat erratic, but not weak. A continuance of present buying in London may advance rates a little, but in the absence of this support the present level seems high enough for the time being. Exports from London to India total \$185,000 to June 28, against \$2,652,000 in this period of 1915, a decrease of 16,000,000 oz. It is considered that the Indian Bazaars are not inclined to take a favorable view of the future, being influenced by reports of Indian government purchases. The Indian market is generally sensitive and swayed by rumor. Chinese sales created an unsettled feeling there. London transactions in 5 months were as follows, in ounces:

	1916	1915
Imports of refined silver	37,502,989	39,275,610
Exports of refined silver	20,563,249	32,518,165

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
July 12	25.75
" 13	25.50
" 14	25.50
" 15	25.50
" 16 Sunday	25.50
" 17	25.25
" 18	25.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 14.21	13.60	24.30	July 13.26	19.09	...
Feb. 14.16	14.38	26.62	Aug. 12.34	17.27	...
Mch. 14.11	14.80	26.65	Sept. 12.02	16.63	...
Apr. 14.19	16.84	38.02	Oct. 11.10	17.90	...
May 13.97	18.71	29.02	Nov. 11.75	18.88	...
June 13.60	19.75	27.47	Dec. 12.75	20.67	...

June outputs were as follows: Braden, 2,258,000 lb.; Miami,

4,516,395 lb.; Old Dominion, 3,813,000 lb.; Greene Cananea, 4,000,000 lb.; and Inspiration, 10,500,000 pounds.

Utah Copper's output in the half-year just ended was 8,900,000 lb., compared with 67,100,000 lb. in 1915. Net earnings, \$16,000,000, are more than double. Anaconda's output was 164,500,000 lb., compared with 126,050,000 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
July 12	6.45
" 13	6.45
" 14	6.40
" 15	6.35
" 16 Sunday	6.35
" 17	6.35
" 18	6.35

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 4.11	3.73	5.95	July 3.86	5.59	...
Feb. 4.02	3.82	6.23	Aug. 3.86	4.67	...
Mch. 3.91	4.04	7.26	Sept. 3.82	4.92	...
Apr. 3.86	4.21	7.79	Oct. 3.60	4.62	...
May 3.90	4.24	7.38	Nov. 3.68	5.15	...
June 3.90	5.75	6.88	Dec. 3.80	5.31	...

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
July 12	9.00
" 13	9.00
" 14	9.00
" 15	9.25
" 16 Sunday	9.12
" 17	9.00
" 18	9.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 5.14	6.30	18.21	July 4.75	20.51	...
Feb. 5.22	9.05	19.59	Aug. 4.75	14.17	...
Mch. 5.12	8.40	18.10	Sept. 5.16	14.14	...
Apr. 4.98	9.78	18.62	Oct. 4.75	14.05	...
May 4.91	17.03	16.01	Nov. 5.01	17.20	...
June 4.84	22.20	12.85	Dec. 5.40	16.75	...

American Zinc, Lead & Smelting Co. pays \$1.50 per share on preferred holders on August 10.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
July 12	80.00
July 13	80.00
July 14	80.00
July 15	80.00
July 16	80.00
July 17	80.00
July 18	80.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 39.25	51.90	222.00	July 37.50	95.00	...
Feb. 39.00	60.00	295.00	Aug. 80.00	93.75	...
Mch. 39.00	75.00	219.00	Sept. 76.25	91.00	...
Apr. 38.90	75.00	111.60	Oct. 72.00	92.90	...
May 39.00	75.00	90.00	Nov. 55.00	101.50	...
June 38.60	90.00	74.70	Dec. 53.10	123.00	...

TIN

Prices in New York, in cents per pound.

Date	Average week ending
July 12	37.50
" 13	37.50
" 14	37.50
" 15	37.50
" 16 Sunday	37.50
" 17	37.50
" 18	37.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. 37.50	31.30	31.26	July 34.60	37.38	...
Feb. 37.76	37.23	42.60	Aug. 30.20	31.37	...
Mch. 38.10	48.76	50.50	Sept. 33.10	33.12	...
Apr. 36.10	48.25	51.19	Oct. 30.10	33.00	...
May 37.20	39.78	49.10	Nov. 35.51	32.00	...
June 30.72	40.16	49.97	Dec. 38.60	38.11	...

Tin is easy at 38.25 cents.

Shares of the Aluminum Co. of America recently sold at \$40 each; a year ago they were \$25 to \$30. Additional capital costing over \$75,000,000, to more so the annual output, from 200,000,000 lb., are nearly complete.

Eastern Metal Market

New York, July 12.

For many months the 'wise ones' have been preaching that the metal market would suffer a reaction. The reaction is here or impending, yet despite the predictions, nearly everyone appears to be shocked at the dullness which has overtaken the market and at the resulting declines in prices. Perhaps the only influence that could check the present trend of copper, zinc, lead, and antimony would be renewed war buying; but none is in sight. It should be remembered, however, that the metal industry is not going to smash by any means, and that prices can decline several points yet, and still be productive of handsome profits. In fact, with an expansion of domestic demand, conditions will be far healthier than they have been, even at lower prices. Everywhere there is a shortage of labor which restrains expansion, but this may be remedied now that the munitions' makers are finishing their contracts, and in most cases not getting new ones.

Copper is inactive and lower.

Zinc is dull and lower, but enquiry from galvanizers is a good symptom.

Lead is lower and dull, although a flurry of buying followed a cut of $\frac{1}{2}$ ¢. The independents are taking what business there is.

The heavy June deliveries are held responsible for a dull market in tin.

Antimony is lower, but consumers show no interest.

Aluminum is a trifle lower.

The iron and steel market generally is quiet, except for export business. Russia has just purchased 365,000 tons of rails, delivery to be completed by July 1917. France and Great Britain also want rails. Russia also purchased 165,000 tons of barb wire, while the Allies are seeking 100,000 tons. Europe is also buying steel-making pig-iron.

COPPER

The market is lifeless, and the nominal prices are lower. Practically the only quotations obtainable are those of offerings made by second-hands or brokers, and it is questionable how much copper could be obtained from these sources. It is suspected that some of the metal offered is being supplied by the smaller producers, in which event perhaps more can be obtained than appears on the surface. The more important producers are well sold up until September, as repeatedly said before, and this is the one sustaining influence. Electrolytic can be had today at close to 25.50¢, cash, New York, and Lake at about 25.75¢, prompt delivery in each case. Consumers have been out of the market for about three months, and there is no indication of any resumption of buying. Sheet copper is quoted at 37.50¢, but it probably could be had $\frac{1}{2}$ ¢ lower. Brass rods are quoted at 38 to 39¢, and sheet brass at the same level. New business in these products is lagging, but the mills have plenty to do in filling existing contracts. Offers made to British buyers at these prices have brought the response that the proffers are "ridiculous." Electrolytic copper at London is down to £128. Exports, July 1 to 11, totaled 4913 tons.

ZINC

Quotations have continued to decline, and buyers have steered clear of the market so far as buying is concerned. Yesterday, however, there was a good volume of enquiry from galvanizers, which at least shows interest on their part. So far no buying has resulted. The brass mills show no inclination to buy. Spot zinc was quoted yesterday at 9¢, New York, and 8.75¢ St. Louis. August was quoted at 8.25¢, St. Louis, and September at 8¢. It is doubtful whether producers are anxious for any extensive business at present levels, most

of them looking for a turn upward in the near future. They are known to be averse to selling round lots for future delivery. The London quotation has been declining, though the downward movement there appears to have come to a halt. The quotation yesterday was £44 for spot. Several reasons are mentioned to account for the present state of the market, among them the lack of domestic and export demand, large stocks, and over-production. Some interest has been aroused by offerings of Japanese spelter in this market, but the quantities so far mentioned are not sufficient to have much influence. A firm of Japanese exporters and importers has offered lots of 50 tons. Exports to the 12th totaled 2124 tons. Sheet zinc has been reduced to 15¢, carload lots, f.o.b. smelter, 8% off for cash. Reports from the West are to the effect that the production of zinc ore is being curtailed.

LEAD

Late on Wednesday, July 5, the A. S. & R. Co., reduced its quotation $\frac{1}{2}$ ¢, or to 6.50¢ per lb., New York, a reduction of \$10 per ton. It is assumed that the company was not getting its share of what little business was doing, and that it did not wish to "hold the umbrella" for the independents any longer. The move did little good, so far as the company was concerned, for the independents at once cut the new price, \$1 and \$2 per ton. Following the cut there was a flurry of business, but it only lasted about one day, and then the market again became quiet. The leading interest yesterday quoted 6.50¢, New York, and 6.42 $\frac{1}{2}$ ¢, St. Louis, while the outsiders asked 6.45¢, New York, and 6.25¢, St. Louis. Lead is the most active of the metals, but as one of the trade says, "this is not saying much." Spot lead at London is quoted at £28. Exports in 12 days totaled 1037 tons.

TIN

The heavy deliveries of June have evidently put a quietus on business for some time to come. In the week ended July 8 only 250 tons was dealt in, and this week the market has been dull to stagnation. Spot Straits was quoted yesterday at 38.50¢, while Banca could be had at 37.75¢. The markets at London and the Straits Settlements are weak, London being quoted at £169 15s. for spot Straits yesterday. Futures are easy. Arrivals this month so far total 725 tons, and there is afloat 2234 tons. Not much is coming to light as to the consumption of the electrolytic tin made by the A. S. & R. Co. at Perth Amboy, New Jersey, but its use is presumed to be satisfactory in view of the company's own tests.

ANTIMONY

In a dead market, spot Chinese and Japanese can be had at 15.50¢, and metal in bond can be contracted for at 12¢. In the latter, a little business has been done. Needle antimony finds no market at 10¢ per lb. It is understood that certain interests which recently engaged in the manufacture of antimony cannot profitably operate their plants with the metal under 30¢ per lb. That money has been lost in antimony is frequently heard.

ALUMINUM

No. 1 virgin aluminum, 98 to 99% pure, is lower at 59 to 61¢.

ORES

Antimony: There is no market, and no quotations are obtainable, nominal or otherwise.

Tungsten: The enquiry for tungsten ore and ferro-tungsten is extremely light. Holders of the former consider that they should receive \$30 to \$35 per unit, while the consumers are not inclined to pay much over \$20. Makers of ferro-tungsten find less demand from the makers of high-speed steel, and are beginning to look rather anxiously for orders.

COMPANY REPORTS

ESPERANZA, LIMITED

This company controls operations of the Esperanza Mining Co., whose property is at El Oro, Mexico. The report of the manager, Charles Hoyle, covers the year 1915, and includes the following general remarks as to operating conditions in Mexico:

Transportation service was badly disarranged during the fall of 1914, and supplies could not be brought up to the mine from El Paso, Texas, nor Vera Cruz, Mexico. There was a slight improvement in view during the last half of December, which was, however, not forthcoming and was completely dissipated on January 26, 1915, when due to a change in political affairs at Mexico City, all rail service was discontinued and El Oro was cut off completely from the outside world. Supplies were carefully stored at Vera Cruz and El Paso, where they were kept in safety until they could be moved. The stock of most of the supplies was gradually exhausted at the mine until there was no cyanide, candles, carbide, electric lamps, nor necessary chemicals for use in the assay-office. A special permit was obtained from one of the higher officials of the Government, and during February and March a carload of supplies was brought down to Irapuato, thence to Celaya and Acambaro, and 30 cases of cyanide were brought over to the mine. During the spring of 1915, rarely was there any communication between El Oro and Mexico City by rail, and at no time was there any freight service available. Travel by the so-called passenger trains was anything but pleasant, and one has but to experience a trip on top of a crowded box-car in the hot sun or rain for a few hours to appreciate the comforts of the situation. The only consolation one had, was that he was not packed inside with his more unfortunate brethren. Letters and newspapers were unheard of for many months at a time. Much of the time watchmen had no illumination at night, and electric-lamp globes became so scarce as to cause serious apprehension; more so, because all foreigners and native employees were entirely unarmed, not even being allowed to have a pocket weapon. The work at the Sirio mine suffered much delay because of the lack of transportation facilities, since the necessary equipment, such as hoist, transformers, motors, compressor, and pumps, could not be sent out from Esperanza. The absolute lack of transportation continued until about November 1, when the newly-recognized Government began to offer a limited service to the public; and during November and December advantage was taken of the opportunity offered, and many necessary supplies from the United States, Mexico City, and Vera Cruz were brought to the mine. El Oro became the centre of revolutionary activity from February until October of the year under review. During the last few days of February the place was, it may be said, completely abandoned, due to the situation, only a few representatives of the mining companies remaining, with the necessary pumpmen to keep the mines from 'drowning.' About this time (March 4), a fire broke out in the town at night, and had it not been for the prompt action on the part of the mining companies, a large part would undoubtedly have been destroyed. At one time fighting took place close to the Esperanza mill, and the 3000 and 440-volt transmission-lines were shot-down and tanks were perforated by bullets. During the changes in control of the El Oro during these months the district was entirely unprotected, and looting and stealing were perpetrated on the defenceless inhabitants by bandits; and it was during just such a situation that about 30 men, armed with rifles, pistols, and machetes, raided the Esperanza property at night, cut their way into the vault in the zinc-room and stole what bullion they could get. One man was killed and two others seriously wounded in the affair. It should be stated that

proper action was immediately taken by those representing the interests of Esperanza in this country, and the matter is being well taken care of, the present Government aiding as much as present conditions will permit. A food shortage naturally obtained on account of the lack of communication, and Esperanza paid its employees in food-stuffs which were brought in overland. At one time 20% of the payroll was being given in the prime necessities of life. When it was seen that operations would be delayed indefinitely, the staff was cut down to the minimum consistent with proper care of the property. Operations, although on a limited scale, were delayed by the lack of sufficient power at times, due to the interrupted service of the power company supplying the current, brought on by the abnormal conditions prevailing. During September, no electric power was available for a period of 14 days at one time. Since only limited transportation was available at this time, sufficient wood for the steam-plants could not be brought to the mine. During the last months of the year labor unrest became apparent and two strikes were declared at El Oro, which, however, were later settled. Special messengers were sent through the various lines whenever opportunity offered, with mail and cables. It is pleasing to state that the mail and telegraph service is again practically normal (February, 1916). It hardly seems necessary to remark on the loyalty displayed by the staff during the unpleasant and critical conditions experienced during the year under review; actions speak louder than words.

Mine development covered 4592 ft., of which 1953 ft. was on the Descubridora vein, and 1788 ft. on the San Rafael vein. Work on the former was encouraging, but the vein is narrow (18 in.) and erratic in value. Results on the San Rafael were discouraging at depth. Some of the ore contains lead and zinc. Two 4-ton Jeffrey electric locos were purchased for use on No. 5 and 7 levels. Diamond-drilling amounted to 938 ft. Ore reserves are estimated at 156,000 metric tons, which should yield \$520,000 profit under normal conditions. There is also 40,000 tons of low-grade slope-filling, and 200,000 tons of tailing, the latter worth \$150,000 net.

The mill treated 25,005 tons, work being suspended on February 25, 1915. The bullion was worth \$143,486, and profit \$57,304. In 1914 and 1915 the total revenue was \$1,186,025, of which \$315,000 was paid in dividends. The balance is \$168,132.

Production to date is 172,344.998 (Mexican) from 2,085,936 tons of ore.

CORDOBA COPPER CO.

This company operates in Spain in charge of James Hocking for the general managers, John Taylor & Sons. During 1915 the average monthly development was 609 ft. Results were disappointing at 1550 ft. in the San Rafael section. The eastern shaft was sunk to 1529 ft. Reserves are estimated at 134,289 tons, containing 2.64% copper. The amount of ore opened did not equal that extracted, namely, 89,639 tons. The position improved later in the year. There was also raised 1,389,227 tons of water, an average of 3806 per day. The pump averaged 5.92 strokes per minute. The rainfall was 39.73 in. Baling raised another 220,449 tons.

The concentration plant treated 48,585 tons of 1.74% ore from dumps. Some ore was hand picked. The Murex plant treated 11,970 tons of middling and slime assaying 1.42%, yielding 1136 tons of 9.45% concentrate. The recovery was 67.67%. Combined with the wet mill the extraction was 79.7. This increased to 73.3% later in the year. The sintering and briquetting plants, together with crude ore, supplied the smelter with 19,184 tons of material. The converters smelted 1767 tons of blister copper.

The revenue was \$630,000, and profit \$14,000. The net balance of \$5000 was carried forward to 1916.

Gold output of the Rand in June was 761,000 oz. and 4,628,000 oz. for the half-year.

RECENT PUBLICATIONS

U. S. Bureau of Mines, Washington, D. C., 1916;

FELDSPARS OF THE NEW ENGLAND AND NORTH APPALACHIAN STATES. A. S. Watts. Bulletin 92, mineral technology 9. P. 181. Ill., maps, index.

ANALYSIS OF PERMISSIBLE EXPLOSIVES. By C. G. Storm. Bulletin 96. P. 88. Ill., index.

ABSTRACTS OF CURRENT DECISIONS ON MINES AND MINING, REPORTED FROM OCTOBER TO DECEMBER, 1915. By J. W. Thompson. Bulletin 118, law serial 7. P. 74.

EFFECTS OF ATMOSPHERES DEFICIENT IN OXYGEN ON SMALL ANIMALS AND MEN. By G. A. Burrell and G. G. Oberfell. Technical paper 22. P. 10.

SENSITIVENESS TO DETONATORS OF TRINITROTOLUENE AND TETRANITROMETHYLANILIN. By Guy B. Taylor and W. C. Cope. Technical paper 145. P. 9.

TECHNOLOGY OF QUARRYING. By Oliver Bowles. Bulletin 106, mineral technology 13. P. 174. Ill., index. A useful publication. In the shaping of marble pieces the use of carborundum in cutting is described.

U. S. Geological Survey, Washington, D. C., 1916:

ABRASIVE MATERIALS IN 1915. By Frank J. Katz. P. 16.

FLUORSPAR IN 1915. By Ernest F. Birchard. P. 9. Chart.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES IN 1915. Mines report. By James M. Hill. P. 14.

GRAPHITE IN 1915. By Edson S. Bastin. P. 13.

SILICA IN 1915. By Frank J. Katz. P. 6.

TALC AND SOAPSTONE IN 1915. By J. S. Diller. P. 4.

MINERALOGIC NOTES. Series 3. By Waldemar T. Schaller. Bulletin 610. P. 164. Illustrated.

POTASH SALTS IN 1915. By W. C. Phalen and W. B. Hicks. P. 39. Abstracts will be made from this bulletin.

THE CADDO OIL AND GAS FIELD, LOUISIANA AND TEXAS. By G. C. Matson. Bulletin 619. P. 62. Maps, index.

NATURAL GAS RESOURCES OF PARTS OF NORTH TEXAS. By E. W. Shaw, G. C. Matson, and C. H. Wegemann. Bulletin 629. P. 128. Ill., maps, charts, index.

GROUND WATER IN SAN JOAQUIN VALLEY, CALIFORNIA. By W. C. Mendenhall, R. B. Dole, and Herman Stabler. Water-supply paper 398. P. 310. Ill., maps, charts, index.

SOME MANGANESE MINES IN VIRGINIA AND MARYLAND. By D. F. Hewitt. Bulletin 640-C. P. 35. Illustrated.

OZOKERITE IN CENTRAL UTAH. By H. M. Robinson. Bulletin 641-A. P. 16. Map.

FACNA OF THE CHAPMAN SANDSTONE OF MAINE. By H. S. Williams and C. L. Breger. Professional paper 89. P. 347. Ill., index.

MICA GNEISS, LIMESTONE, AND SCHIST IN CHESTER COUNTY, PENNSYLVANIA. By E. F. Bliss and A. I. Jonas. Professional paper 98-B. P. 26. Ill., charts.

RETREAT OF BARRY GLACIER, PORT WELLS, PRINCE WILLIAM SOUND, ALASKA, BETWEEN 1910 AND 1914. By B. L. Johnson. Professional paper 98-C. P. 2. Illustrated.

EXPERIMENTS ON THE EXTRACTION OF POTASH FROM WYOMINGITE. By Roger C. Wells. Professional paper 98-D. P. 1.

PETROLEUM WITHDRAWALS AND RESTORATIONS AFFECTING THE PUBLIC DOMAIN. By Max W. Ball. Bulletin 623. P. 427. Eight State maps. This is a much-discussed subject, and the bulletin will be of value to many interested. The area included in the petroleum withdrawals on January 15, 1916, totaled 5,587,077 acres, of which 1,507,547 was in California and 1,952,326 in Utah. The map of California is by J. H. G. Wolf, a contributor to the PRESS.

REVISION OF THE BECKWITH AND BEAR RIVER FORMATIONS OF SOUTH-EASTERN IDAHO. By G. R. Mansfield and P. V. Roundy. Professional paper 98-G. P. 9. Illustrated.

INDUSTRIAL NOTES

Information supplied by the manufacturers

The Seattle office of the LIDGERWOOD MFG. Co. has been moved from 807-809 Western Avenue to 63-65 Columbia Street.

The CYANIDE PLANT SUPPLY Co. writes that the War makes it necessary for it to have offices in Victoria street, Westminster, London, so they are now at No. 28 on that street.

Electric hoists of half and one-ton capacity, type S-1, are discussed and illustrated in Bulletin 48,906 of the SPRAGUE ELECTRIC WORKS of the GENERAL ELECTRIC Co. Complete dimensions are given of the various sizes.

In its pamphlet No. 28-B the COLORADO IRON WORKS Co. of Denver describes its Portland continuous revolving-drum type vacuum-filter. Use of the machine for dewatering flotation concentrate, and filtering and washing cyanide slime is illustrated. A list of users is given.

The AMERICAN MANGANESE STEEL Co. of Chicago announces the purchase of the Brylson Steel Casting Co.'s plant at New Castle, Delaware. This modern foundry has a monthly capacity of 400 tons of steel, and will be making manganese steel by July 15.

The Black Prince Tungsten mill, near Boulder, Colorado, was recently completed and put in operation by the DENVER QUARTZ MILL & CRUSHER Co., for John T. Duncan. It is to have an additional unit supplied by this firm, for delivery by July 15. When in operation the capacity of the mill will be 75 tons per day.

The GENERAL NAVAL STORES Co. of New York announces that it will hereafter carry stocks of G. N. S. flotation oils at Denver, and will be in a position to fill orders from that point within the next 30 days, following June 21. John D. Davis, with office at 1550 Glenarm street, Denver is the Colorado representative.

The latest folder, No. 64, of the CHAIN BELT Co. of Milwaukee, gives information on its traveling water-screens. These screens are designed primarily to remove refuse and foreign material from water before it enters power-plants, steel mills, or any other industrial plant requiring large quantities of clean water.

The Sprague Electric Works of the GENERAL ELECTRIC Co. has issued bulletins 48,706, 48,907, and 49,600. The first deals with motors and controllers for flat-bed and small rotary printing-presses; the second with 500-lb. electric-hoists for shop use; and the third covers flexible-steel armored conductors, steel conduit, fittings, and tools.

The latest bulletin of the HENDRIE & BOLTHOFF MFG. & SUPPLY Co. of Denver describes and illustrates the Leadville drill-column hoist. Five pages discuss the 'super-Leadville' hoist, model 5, which is designed for loads up to 1200 lb., against 700 lb. by the regular sized machine. A 4½-hp. air engine is used. The drum holds 1080 ft. of ½-in. rope. Total weight is 360 lb. net.

In a circular entitled 'Flotation,' the UNITED NAVAL STORES Co. of New York, states that wood-cresote leads in quantities used, compared with the other oils or tars, excepting petroleum oil. Pine-oil was originally at the head of the list, but while it became scarce, and high in price, the wood-cresote was found to give results just as good in most instances. Eventually wood-tar will probably replace most of the wood cresotes, and other oils in flotation, because it contains about 50% of the wood-cresote in a crude form, besides light oils; because its cost is less than one-half of the wood-cresote; and because there is more of it produced than all the other wood-products combined. This is backed also by the fact that a number of mining concerns are now using it in considerable quantities.



EDITORIAL

T. A. RICKARD, Editor



WAR exports have not ceased by any means. In three days \$31,757,418 worth of such material went out of New York. This included \$5,501,903 of copper ingots and \$12,593,319 of explosives.

SURFACE TENSION is a term used with such wearisome iteration in writings on flotation that it seems worth while to agree upon an abbreviation. 'S.T.' is disagreeable, so we suggest 'sur. ten.' Eventually, we may write it 'surten,' for convenience.

PAPER is expensive, because so much of it is wasted. The Government bureaus issue tons of printed paper much of which is just so much good pulp squandered in the effort to make a showing before Congress. We have just received the Monthly Review of the U. S. Bureau of Labor Statistics. We wonder who reads it.

UNDoubtedly trade in War supplies has diverted interest from the effort to open new lines of trade with South America and Asia. We heard a lot about opportunities in those directions during the early stages of the War, but not much lately, except the excellent propaganda of the National City Bank of New York. That has done a great deal of useful work.

REFERRING to the article on the financial chaos in Mexico appearing in our issue of July 15, we can add now that an official decree imposes the death penalty on a Mexican and deportation on a foreigner that refuses to accept the Carranza *infalsificable* currency at its enforced value, of 20 centavos or 10 cents gold per peso. Incidentally this currency bears upon it no statement of any obligation to pay.

ALASKA is prospering. Recent reviews of mining lay stress on the growth of copper production, now contributed by 15 enterprises, chiefly in the region tributary to Cordova and near the railway being built to Fairbanks. Mining for gold is lively, especially around Juneau, where big developments are in progress. We are glad therefore to announce that Mr. Emil E. Hurja, who made a tour through Alaska and the Yukon in our behalf last year, is now re-visiting the mining districts of the North, or more accurately North-West, and will contribute a series of articles describing the principal operations. In this issue we give the first of the series, an article on the Ketchikan district.

GOLD mining in Western Australia, and elsewhere under the flag of the great belligerents, is suffering from the imposts necessitated by the expenses of warfare. At Kalgoorlie, for example, the mining companies have

not only to pay more for all their supplies and equipment, by reason of abnormal freight rates and scarcity of skilled labor, but they have to face the Federal land tax, the Federal income-tax, and the State profit tax. Under the last of these an attempt was made to treat the cost of development as 'profit,' but a favorable verdict in a test case has side-tracked this absurdity, pending appeal to a higher court. It is bad enough to treat dividends as income if paid by a mine that has not yet redeemed its capital expenditure. A mine is a wasting asset and the dividends paid by it do not represent 'profit' until its purchase price and equipment have been amortized. People forget this because they keep an eye on the shares, not the mine.

BLACK-LISTING of firms in this country by order of the British government will affect sundry metal-producing enterprises and it has aroused the interest of many engaged in mining. One local firm that does a big business in oil with Australia is on the list. This presumably is a part of the economic warfare that is to follow present hostilities in Europe. It is none of our business what the belligerents do to each other and we do not doubt that the Entente agreement to restrict the commerce of the Central powers is in response to the Zollverein that the latter have organized among themselves. Nor do we question the right, or even the advisability, of a belligerent discriminating against those that aid his enemy, but we do question the wisdom of publishing a black-list and thereby martyring a number of persons or corporations and arousing a reasonable irritation. This, we take it, is the first gun in an international trade war, to be waged with greater intensity as soon as military operations cease. It may be ungracious to comment on this policy, but we doubt either the success or the continuance of it for long. Great Britain, naturally, will abandon free-trade and protect herself, as she ought to have done long ago, against the syndication, cartels, dumping, and bounty systems that prevailed at her expense in central Europe, but neither Great Britain, France, nor Russia can start a general black-listing of firms in neutral countries without introducing a kind of medieval reprisals that will do as much harm to them as to their enemies. We expect a modification of sentiment on the question when the intense acerbities of the War become alleviated by time.

USEFUL service has been rendered to mining by the American Mining Congress, but its entry into journalism is probably the least useful of its services to the industry. The July publication contains some startling announcements suggestive of the misinformation com-

mon in the daily papers. One head-line announces "Lake Superior iron mines shipping ore at rate of 2,000,000 tons monthly." This is a statement that will surprise anyone who knows anything about Lake Superior, for it would indicate an annual shipment of 24,000,000 tons, when as a matter of fact, the 1916 shipment is estimated at 60,000,000 tons or $2\frac{1}{2}$ times the amount stated. The editor of the Mining Congress Journal appears to have divided the 10,000,000 tons shipped during the first five months of the year by five, forgetting that shipping does not open on the lakes until the middle of April. Another thriller says "Nevada's copper output is double that of last year." This would mean that the Nevada Consolidated, instead of producing 62,726,651 pounds, as in 1915, is producing at the rate of 125,000,000 pounds per annum. That is not what has happened. It is the value of the output that has been nearly doubled, thanks to the combined effect of better prices and a 50% increase in tonnage.

BOLIVIAN tin was discussed comprehensively by Mr. Howland Bancroft in our issue of last week. As noted by him, the mining and milling methods in use on the Andean plateau are crude and unscientific. The importance of tin to the industries of the United States is not generally recognized. During the past five years the value of the tin imported into this country has averaged \$45,000,000 per annum. This compares with the value of this country's output of primary spelter in 1914 of \$36,011,000 and of primary lead during the same year of \$42,286,000. In other words, the normal production of zinc or lead in this country has been of less value than the tin imported. A ton of tin is worth in ordinary times nearly ten tons of lead or zinc. This country uses 55,000 tons of tin per year, about 1000 tons per week. The new tin smelter of the American Smelting & Refining Co., at Perth Amboy, will produce only 100 tons of metal per week, 10% of the American consumption, when it attains to full capacity. Tin mining and smelting should offer an attractive field to American enterprise and we would like to see the establishment of a tin smelter on this coast, with a view to supplying the regional requirements in tin-plate,terne-plate, and alloys.

RIO TINTO is the largest copper mine in Europe. The mine is in the province of Huelva, in southwestern Spain, and the company owns the railway to the port of Huelva. During 1915 the dividend paid was 55%, compared with 35% in the preceding year. The net profit was \$6,189,005, against \$3,588,155 in 1914. Income is obtained both from sale of metal and pyrite. In 1913, a normal year, the copper produced at the mines was 21,062 long tons, while 635,900 tons of pyrite was sold, besides 825,408 tons of washed and other sulphide ores, for the manufacture of acid. A total of 1,859,571 tons of 2.19% ore was mined, practically all by open-cut methods, the metal produced amounting to 36,320 tons, which was more than the output of the Calumet & Hecla or any of the American disseminated copper mines dur-

ing that year, except the Utah Copper. The Rio Tinto mines are owned by an English company that acquired them in 1872 at a cost of approximately \$19,466,000. The French have a large holding of shares. About 10,000 men are employed, and four villages are included in the nine square miles of property. The mines have been worked successfully by the Iberians, Phoenicians, Carthaginians, Romans, and British.

FLOTATION is to the fore in this issue, two articles being devoted to the subject. Mr. Joel H. Hildebrand, Assistant Professor of Chemistry in the University of California, discusses and illuminates underlying principles from the point of view of the physicist. Undoubtedly we want more of this kind of scientific study, for the actual use of the process in the mill cannot be intelligent, and is unlikely to be progressive, unless it is based on a clear understanding of the physical phenomena underlying the rationale of this metallurgical method. We believe that Dr. Hildebrand's contribution will help many of our readers to a better conception of elementary principles. Next we reproduce a bulletin just issued by the U. S. Bureau of Mines, embodying a study of flotation as applied to oxidized ores. Messrs. O. C. Ralston and Glen L. Allen, of the Salt Lake City branch of the Bureau, need no introduction to our readers. The subject they discuss is of the most timely interest. Several months ago we announced that Mr. Joseph T. Terry, Jr., had found a way of treating oxidized copper ores. His method, like those described by Messrs. Ralston and Allen, depends upon sulphidizing the carbonates, forming a film of sulphide that aids flotation. Similar tests on lead-carbonate ores show that sodium sulphide is the best agent for the purpose, and it is now being adopted at Pioche. The results are encouraging and promise to enlarge the field of usefulness, already wide, of the flotation process.

ATTENTION has been drawn to the unpreparedness of this country in regard to many things by the disturbance of normal trade relations during the European war. The stimulus that this discovery of weakness is giving to the chemical industry in particular will have far-reaching results. The man with a process for extracting potash from feldspar no longer is regarded as a crank; indeed it has come to be expected that the potash chemist will take a place in the industrial ranks of the day as a matter of course. The Cushman and Coggeshall process for making the chloride has established the fact that from American feldspar a product may be made equal to that formerly imported from Europe. Another simple method is that known as the Hart process, based upon the fusion of feldspar with sodium sulphate and carbon, extraction with sulphuric acid, and precipitation of the potash as an alum. This is an attractive field for the chemist possessed with that sort of imagination which is dubbed inventive genius. Mr. Chester D. Gilbert of the Smithsonian Institution has recently sent out a call for efforts to discover some more economical and practicable means of oxidizing ammonia obtained

in by-product coking so as to make cheaper nitric acid. At the present time the production of ammonia sulphate in the coking of coals in this country is about 225,000 tons per annum. With the plants now under construction this quantity will be double in the next twelve months. The possible output is above 700,000 tons. In other words, the fixed nitrogen represented by 475,000 tons of ammonium sulphate is yearly being wasted because in that form no adequate market exists. Here is a great opportunity for chemical ingenuity. Not only is nitric acid needed for the manufacture of fertilizers, but as a military necessity it is one of the urgent affairs connected with that preparedness which an awakened people will insist upon, no matter who may have the shaping of our political destinies during the next four years. The Government is giving considerable attention to the possibilities of utilizing our unemployed water-power in the fixation of nitrogen in the form of calcium cyanamid, but the waste from our crude methods of coking is one of the sad facts of industry that should stimulate chemists to remove this blot from an epoch that boasts of conservation and progress.

The Mexican Muddle

We publish a timely letter from Mr. E. A. H. Tays, a mining engineer recently resident in Sinaloa, who corroborates and amplifies the description of Mexican financial conditions as given by our regular correspondent in the issue of July 15. Mr. Tays writes, as many mining men would, in a spirit of goodwill toward the unhappy country in which he has lived and worked from choice. That makes his complaint all the more convincing. To him and to the scores of other engineers and operators driven out of Mexico owing to the withdrawal of protection by their own government, we proffer our understanding sympathy. Their disappointment and disgust is natural. Dispossessed of their property and driven from their work, they may be pardoned for even more irritation than they express. Meanwhile the pitiful farce continues to unfold like an endless cinema-film, punctuated with scenes of lurid brutality. The latest proposal, that of an international commission of eminent American and Mexican citizens, seems to us only "the passing of the buck" to the next man, a mere shifting of responsibility and a postponement of action. The trouble with Mexico is that it has no effective government, the administration at Washington having recognized a group of predatory politicians as a *de facto* government. Under the anarchy that results from political chaos, our own territory has been invaded by bands of marauders, whom the Mexican rulers are unable to suppress and whom our soldiers are forbidden further to pursue under threat of war with Mexico. Villa is again in command of large forces and is making faces at both administrations, that of Señor Carranza and that of Mr. Wilson. We have to maintain a large force of citizen soldiers along the border to protect ourselves from the inhabitants of a country

whose government we recognized prematurely as responsible and capable of maintaining order. Disorder reigns supreme. Six weeks is likely to be wasted in further parleys between the members of the Commission while famine drives more of the unhappy peons into Villa's mob of looters and desperadoes. To join one of the so-called armies in Mexico is now the best way to get something to eat. No kind of settlement of the Mexican question is possible until Mexico has a real government, able to represent the Mexican people in negotiations for the adjustment of grievances and able to redress the calamitous condition of the country. 'Watchful waiting' at Washington, 'wait and see' at London, and *mañana* at Mexico City are all expressions of political incapacity.

On July 31 Señor Carranza decreed the nullification of all civil records made during "the usurpation administrations" of his predecessors. This is to be mitigated by re-validation on appeal to the authorities now in control, thereby opening unlimited probabilities of graft. Until the end of the current year is the time set for such re-validation. This action, we understand, was prompted by Señor Luis Cabrera, who with General Alvaro Obregon constitutes the power behind the tinsel throne of the First Chief. That gentleman has placated native sentiment by issuing insulting statements for domestic consumption while sending polite notes to Washington, but this double play will prove ineffective unless Villa and his followers are crushed. These, of course, hope to unsaddle Señor Carranza from his unsteady seat by appealing to anti-foreign sentiment and they will succeed unless the *de facto* Government is more cordially supported by the other military adventurers of the Constitutional party than is apparent. The Mexican problem persists and no make-believe will solve it. We believe that conditions will have to be worse before they are better and that the logic of events will prove too strong for any commission of enquiry, like the Niagara conference, which left no mark on current history, only a memorandum of conversations.

Publicity in Mining

When the Engineering Congress was in session in San Francisco, last year, a usually well-informed engineer made the remark that he supposed mining along the Mother Lode was dead, as he had heard nothing about it recently. We assured him that the region to which he referred so casually was in a state of remarkable prosperity and that to it largely California owed her first place among the States of the Union as a producer of gold. The articles that have appeared since then in this paper will have told that engineer, in New York, a good deal concerning one of the principal gold-mining regions of North America. But how came it that he should have labored under such a misapprehension? The answer is that the mining companies operating on the Mother Lode consist for the larger part of privy, technicalities and syndicates, most of which desire no publicity, and some even endeavor to escape it. Is this wise? We have ours

cussed the matter with several of the principal operators, men of wide experience and high character, and from them have elicited the reasons why they are content to work their mines without attracting public notice. What applies to them and their operations will apply to others elsewhere to whom publicity is repugnant. In the first place, they argue that any advertisement of their profits tends to invite the attack of the labor agitator and even the less arrogant claims of the labor-union, because a show of large production and successful results gives ground for a demand that wages be raised and so forth. In the same category we may place the idea that a statement of production and profit gives the tax-collector an excuse for raising his impost. To this we would reply that mystery always exaggerates, that a mine operated secretly is the sport of fanciful stories, that the actual profit made by a mine is nearly always less than that reported in the adjoining community, for example, in the hotels and saloons of adjacent towns. If the assessor wants to get at the facts, he is empowered by law to obtain them; and if the labor agitator is anxious to ascertain how much money a mining company is making, he can do so by enquiring among the men working on the mine, obtaining from them usually a highly-colored version of the figures in the case. In short, we believe that secrecy does not protect; on the contrary, it renders a mining company particularly vulnerable to injury from such sources. Next, we are informed that the small company, working its own mine in its own way, has no stock to sell and no share quotations to boost. That is well. We recognize that the kind of mining done by such proprietaries, on the Mother Lode and elsewhere, represents a clean operation; it aims to extract gold to the profit of the proprietors and not to victimize the public by selling shares at an inflated price. So far, so good. But the State of California, the city of San Francisco, and the county in which the mining is being done are each and all entitled to be considered in the matter, and as good citizens, these modest operators should consider them. It is to the advantage of the State, county, and city that honorable and successful work of this kind should be made known, so that our domestic mining industry may receive public support. Gold mining is a business that is not hurt by competition. We cannot see how a disclosure of facts creditable to all concerned is going to do any harm to anybody. We do not insist that the mines be listed on the local stock-exchange, but we venture to point out that a holding in a privately-owned property is not a liquid asset. If any member of a small syndicate or private company owning a mining enterprise that courts seclusion should wish to sell his interest, as is frequently the case in any business, he has no market outside the members of his group, because nobody knows anything about the mine outside that group. A property is enhanced in value by becoming a liquid asset. We hope to be pardoned for discussing the matter frankly. Far be it from us to teach our grandmother the pneumatic extraction of the aluminous contents of an egg. However, we hope our friends on the Mother Lode

will consider the matter seriously. A great deal of new and promising work is being done along the foot-hills of Amador, Calaveras, and Tuolumne counties at the present time. Old mines are being re-opened, many of the deepest mines are doing handsomely, and there is every reason, it seems to us, why the world at large should be informed concerning the excellent work in progress.

Copper, Zinc, and Lead

In 1913, before the War created abnormal conditions, the world's production of copper, zinc, and lead was respectively 1,002,284 metric tons, 999,890 metric tons, and 1,142,264 metric tons. In round numbers the production of each of the three metals was a million tons. In 1900, the total output of copper, zinc, and lead was respectively 491,435 metric tons, 479,128 metric tons, and 849,168 metric tons. Thus, 16 years ago the production of copper and zinc was half what it is now, while that of lead was only a quarter less. From 1900 to 1913, the average price of copper varied between 12 and 20 cents per pound, that of zinc between 5 and 7, and that of lead between 4 and 6 cents. Obviously, if the conditions of mining and smelting these three metals were such that they could be produced at the same cost, and the amount of each metal required by the world remained as shown above, then the price of each would be the same, disregarding the possible effect of monopolies and selling agreements. However, if the price of these base metals became equal, the demand would cease to be equal, because copper would be preferred for purposes for which zinc and lead are at present used and for which copper is now too expensive. Copper has more valuable properties than either zinc or lead, being tougher, more ductile, a better conductor of electricity, and more attractive in appearance. Again, the higher value of the metal enables the miner to exploit deposits of copper that are much lower in grade than the equivalent deposits of zinc or lead. The copper of Michigan comes from ores that average 1% in copper; the production of many of the other great copper mines of the world, including the disseminated chalcocite deposits of the Western States, the Braden and Chuquibamata in Chile, and the Rio Tinto in Spain, is derived from ores of about 2% grade, varying from 1.5 to 3%. Ores of zinc and lead, on the other hand, are plentiful in much higher ratios. The Butte & Superior mine in Montana, which is now contributing 12% of the American production of zinc, is mining ore containing 16% zinc. The mines of Broken Hill, in Australia, yield ore containing 12% zinc and 14% lead, with about 10 ounces of silver per ton. The Consolidated Interstate-Callahan mine in Idaho has ore running from 20 to 30% zinc. The Bunker Hill & Sullivan lead-silver mines, also in the Coeur d'Alene, produced 37,292 tons of lead in 1915 from ore averaging 8% lead. It is true that in south-east Missouri the companies mining disseminated ore successfully treat material of 3% lead, but conditions there are exceptionally favorable to a low cost of exploitation.



DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes the expression of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Conditions in Mexico

The Editor:

Sir—It is a pity that editorials like 'The Mexican Fizzle,' and articles like 'Conditions in Mexico,' to be found in your issue of July 15, could not be read by the President and his advisers. I should like to add to what your correspondent has said.

No Mexican dares to criticize, publicly, public acts, but we have been reared to believe no public servant can be exempt from criticism unless his public life is exemplary. The President, the General, the Governor, in Mexico, is not a public servant; he is an over-lord. What is power for, if not to be used? For the public weal? Well, hardly, unless the public weal coincides with personal aims. However, my remarks are in no way meant as derogatory to Mexico or its people. It must be understood by the American people that the present Government does not represent Mexico or its people; and, also, that most of the Mexican people are friendly to the American people, and there is no country in the world where a decent law-abiding foreigner is shown more respect and courtesy. It should also be understood by the Mexican people that the Mexican people themselves are Mexico's greatest enemy and not the U. S. Government. Mexico is now in the hands of the very worst elements in the country, with a very few exceptions. Señor Carranza himself is an educated and wealthy man, but he belongs to the old school, and whatever he may believe to the contrary, having had no training in democracy, and having been raised in the old vice-regal atmosphere, his idea of government can be only domination. He has even changed an article of the Mexican Constitution (Art. 5, if I am not mistaken) by decree, and that too, at a time when he was nothing but the head of a warring faction, and could have none of the powers with which he thought himself invested. Before this, although fighting for Constitutional rights, he tried to depose the constitutionally elected governor of Sinaloa, who had given him material aid at a time when it was vital to Carranza. And he would have deposed the governor had not he met determined opposition from General Carrazo. I mention this only to show what the First Chief is. He is surrounded by some able men, but most of the officers of his army are ignorant and dishonest, many being unable to read or write, and only a very few having more than a sixth-grade education. I refer to this merely to sustain my statement that the country is now in the hands of the very worst elements in Mexico, and to show the futility of expecting a gov-

ernment of any character while such factors are in control. They do not represent the Mexican people.

During the last two years the Mexican people have been robbed and murdered and every vestige of rights ignored, and the foreigner has fared the same. The best people—the educated and the wealthy—have been driven out of the country. And now the American government has forced all Americans out of Mexico instead of demanding that our rights as foreign citizens be respected, enforcing the demands if not heeded. The course adopted by the Administration is bringing about, not intervention, but just what neither country desires, war. The bulk of the middle class is tired and sick of the present muddle, and the great peon class is apathetic. But all are cowed, and, for a number of reasons not necessary to discuss, bow the head. I said to a young fellow who was criticizing conditions: "There surely is one way to alter them." "What! I bear arms?" he asked excitedly and in a deprecatory way. "Yes, my friend, either that or you will bear the burden."

I have digressed from my original intention of adding a little light to the monetary situation in order to give some light on the inner conditions that are less known, so that the whole may be better understood. Right here let me repeat: The Mexican people have no enmity for the law-abiding decent foreigner. Whatever men's motives, they can only be judged by their public acts, and the present financial muddle in Mexico certainly reflects no credit on the Government. Your correspondent would lay the chief blame on Señor Cabrera. But such is not just, for the decrees are signed by V. Carranza, and the blame must be laid wholly on his government. When the first fiat money was issued, it was forced into circulation at par with the peso, and a peso is, legally, one ounce of silver 902.7 fine. Although the people at large were not enthusiastic in the reception given the new paper money (and it was very crude at first) still, as it was issued under penalty of fine and imprisonment and was really the lesser of two evils—the other being forced loans—it went into general circulation at par and remained so for some time. The early bills, issued in good faith, all had an expressed obligation on the face of them. The State or the Army Corps, or the Constitutionalist Army "will pay the bearer one peso." These were counterfeited, of course, but it is publicly believed by the Mexican people that the statement by your correspondent that the Government issued two forms of the same bill and called one counterfeit after it was once in circulation, is a fact. It is hardly to be believed that

anyone would copy a bill exactly and then put on the signatures one-half or double the size of the original, as in the case of the Monclova issue. I commented on this with a member of Señor Carranza's cabinet, and he, of course, refuted the charge. "But," I told him, "I have seen the brand new bills of the so-called counterfeits put directly into circulation by the troops." To this he replied that they had notice that some of the Army paymasters had bought up counterfeit issues (at a low price, of course) and had issued them to the troops, keeping the legitimate issue. He also said that they could do nothing toward punishing such acts at that time. When these bona-fide issues were retired later by decree, without being redeemed, they were replaced by the Vera Cruz issues of the Constitutional government, afterward called the *rescaldados*. Instead of bearing a promise to pay, the legend read: "Will pay this bill." The animus is evident at that date. These bills, the Government said again and again, over the signature of Señor Carranza, would be respected and would never be repudiated. Your correspondent shows how they were thrown out of circulation, being replaced by a new, so-called *infalsificable* bill, which the Mexican public believes meant (and I am only voicing what I have heard many Mexicans say) that the Government would only make one issue and respect it. But this issue, the best made and a handsome bill, bears no obligation on it at all. On the reverse side it has this note: "This bill will circulate in accord with the decree of July 21, 1915," a year before this issue was put into circulation.

This would have been acceptable had it replaced the old issues at par and been exchanged for the five hundred million pesos acknowledged to have been issued by the Government. A like amount of the new bills was printed. But the various decrees, one following the other rapidly, forced the old issues out of circulation by June 30, and any one holding them after that date became liable to fine and imprisonment, and the bills would be void. The decree ordered all bills to be turned into the Treasury offices with a triplicate list, having on them a complete description of each bill, a job much easier ordered than complied with. But the new *infalsificable* was put into circulation *per se*, to be exchanged for the old at 1:1. This itself, although rated at, let us say, one peso, was valued by the Government at 20 centavos Mexican gold (10 cents U. S. currency) for redemption purposes. This 20 cents was offered for four pesos of the old bills that had been issued at par, and par value received for them in Mexico; or, in other words, the old would be redeemed at 5 centavos on the peso, and with a bill that had less behind it than the old—no more surely. A neat way of honestly reducing the national obligation 95%! What it did do was to produce consternation and absolute bankruptcy and alienate 95% of the sympathy of the people from the Government.

To the above we can now add that a decree has fixed the death penalty for all natives who refuse to take the *infalsificable* bills at the Government rate, 10 cents U. S. gold per peso, and the foreigner refusing them will have

Art. 33 of the Constitution applied to him, which means, deportation as an undesirable alien.

All taxes, however, are payable in Mexican gold; and, in the case of mining, have been doubled. But, as one could not raise one thousand dollars of Mexican coin in any State, under penalty of death for failure, as practically no Mexican gold has ever been in circulation at any time, it simply reduces down to all taxes having to be paid in U. S. currency. But you are fined if you dare offer anything for sale in exchange for U. S. gold. I can cite two cases, within my personal knowledge, of persons that were fined.

In October last, I believe, a bill of the *Ejército Constitucionalista*, called the *aguila negra*, was decreed out of circulation as counterfeit, notwithstanding the fact that much had been put in direct circulation by the Army itself. Last April (1916) this same bill was decreed into circulation again, at least on the West Coast, but went out again with all the rest. These are facts, not dreams nor vagaries. What need has any Government of Mexico for such tricks? Say 500,000,000 pesos (\$250,000,000 U. S. gold) has been issued, and even if half has been squandered or stolen, it remains a sacred obligation on the present Administration, for the portion used honestly put that administration in power and should be honestly accepted. What is \$250,000,000 in gold as a debt for a country like Mexico if decently governed? In two years of peace and honest government, not a sign of the present distress would be apparent, and only the debt would remain; but, if honestly borne by all, it would fall lightly on all and be onerous on none. The people at large, the workers, pay it anyway. It will certainly not be paid by Señor Carranza or any or all of his collaborators. Then why try to wipe out the obligation in such a way that it falls so heavily on the holders of the bills as to induce absolute bankruptcy and loss of national honor and consequent loss of credit? It certainly needs no special financial ability to readily see the sure way out of the difficulty. With its natural resources, the little State of Sinaloa alone, 100 miles wide by 400 miles long, can support 25,000,000 people, and alone could assume all of the Mexican national debt of 1,000,000,000 pesos, or \$500,000,000 gold. Of course, if the Mexican nation at large puts up with such dealings by the clique in power (150,000 at the outside, out of a population of 15,000,000) outsiders have nothing to say. That we must concede, even if the Mexican population is too supine to submit. But, when the foreigner goes to Mexico under treaty rights and is shuffled out of most of a life-time's earnings in the manner described (to state the case mildly), has he to submit, has he no right to state his case and demand remuneration for honest loss? Has his government no obligation to enforce an honest settlement in case the Mexican government should ignore his rights, as the present government is ignoring the rights of its own citizens? Mexicans may have to stand for it. Do we?

E. A. H. TAYLOR.

Berkeley, California, July 20.

Mining in Arizona

By Charles F. Willis

THE mines and smelters of Arizona have been working at so high a pressure in 1916 that they are making record productions all round. If they continue at the present rate, they will make an output of 600,000,000 lb. of copper, against 432,467,690 in 1915, according to reports received by the U. S. Geological Survey from Victor C. Heikes of the Salt Lake office. A corresponding increase in the output of the precious metals, and a gain in that of lead and zinc at the greatly increased prices, will make the total value of the metallic output in 1916 nearly double that of 1915, which was about \$88,000,000. Arizona not only retains first place as a copper producer, but is yielding at a rate nearly twice that of any other State. Aside from the unusually active market, several factors have aided this increase, such as the settlement of the strike at the Clifton-Morenci mines in January. The International smelter, which treats ore from the Inspiration mine, contributes the greatest part of the increase, for this plant is supplying one-quarter of the State's total output of copper. Increases and improvements were also made at the United Verde, Miami, Calumet & Arizona, and Old Dominion mines; and the Saseo smelter in Pima county was again blown-in. The railroad to Ajo was completed and work begun on the 4000-ton leaching plant.

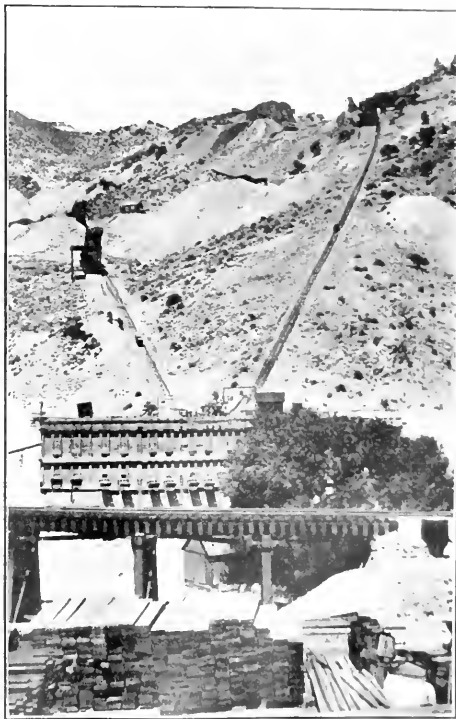
Tungsten has furnished excitement, but the total aggregate production is small compared with copper. Oatman has had a real boom, but gold plays a relatively small part in the total value of the State's metals.

It is proposed in the revenue bill before Congress to place a tax upon copper smelting, singling out copper from all the other metals. Yet the copper stocks of Arizona have not been characteristic 'war babies.' The Inspiration mine, which is increasing the copper production of the State over 25%, is in no way a product of the great contest across the Atlantic. The New Cornelia at Ajo, which will add 32,000,000 lb. of copper to the annual production, likewise was planned long before the War.

It is true, of course, that practically all of the larger mines have increased their production, owing to the high prices, but they are disturbed in their plans for immediate expansion by a notification from Eastern refineries that they have received more copper bars than they are able to handle at present. In consequence, the Copper Queen is restricting its output to about 15,000,000 lb. per month. At the Calumet & Arizona smelter the same condition is understood to apply, the refiners having notified the management of the congestion now existing, which has caused them to stack copper bullion instead of immediately refining it. The output there was

approximately 7,600,000 lb. per month. The Kansas City Structural Steel Co. is erecting derricks at the C. & A. for handling the steel for the new roaster addition, the acid-plant, enlargement of the power-house, and machine-shop. The foundation for the acid-plant was completed several weeks ago, and much of the steel has arrived.

Since the end of the miners' strike, the Shannon Copper Co. has shown a steady increase in production. In



WILSON AND METCALI IN LINES OF ARIZONA COPPER CO. AT METCALI

May the output was 1,071,000 lb. of copper, an increase of nearly 100,000 lb. over April. The cost of production at the Shannon is higher than that of any other Arizonan company. Apparently it costs about 18 cents to turn out a pound of copper, but the average May selling price was 28.625c, and the total earnings for the month were a trifle under \$100,000. During the first five months of 1916 the Shannon earned \$220,000 net. This amounts to about \$1 for each share of outstanding stock, and advices from the East are that the stock

holders are expecting a dividend soon. There is no necessity for accumulating a greater surplus, for the company had a working capital of more than \$750,000 on June 1. Of this sum, however, \$190,000 is set aside for the retirement of the Shannon-Arizona railway bonds.

The production at the Old Dominion smelter for the month of June was slightly in excess of 3,000,000 lb. In addition to the copper produced at the Old Dominion smelter, there was over 750,000 lb. produced from Old Dominion and United Globe concentrates at the International smelter. The Old Dominion smelter is at present taking a considerable tonnage of custom ores from the outlying portions of the district, as well as from the United Verde Extension mine at Jerome. Shipments are also being made from several of the old dumps on the company's property that show a profit at present copper prices by sorting thoroughly. Four furnaces are being operated. At the smelter power-house the converter-engine is being installed on its new foundation and should be running by the middle of July. Foundations are in place at the boiler-plant for two additional Stirling boilers. At the concentrator 800 tons is being treated daily, while the flotation-plant is treating about 300 tons of ore per day.

Several minor improvements are being made in the mill, including the installation of Senn vanners and cone-classifiers. A Marathon mill is also being erected to experiment with fine grinding. Two additional concrete concentrate-tanks are being built outside of the concentrator, and a slime-pond for settling slime is being constructed on the old Hamm lands.

In the mine department of the Old Dominion, 1200 tons is being hoisted daily. Most of this comes from the 12th, 14th, and 16th levels. A little stoping is being done in the upper levels for cleaning-up what remains of old orebodies. Development on the 10th level is being advanced near the Grey shaft to open the Old Dominion vein at that point. A drift on the 14th level is being pushed east of the Grey shaft to prospect the vein between the Grey and the Arizona Commercial-Copper Hill shaft. On the 18th level at A shaft, work has been resumed in the foot-wall drift, and it is expected that this drift will be connected and ready for operating within the next few months. The station on the 18th level at the A shaft is also practically finished. Development is proceeding west on the 17th and 18th levels from the west winze, where the conditions look favorable. Steps are being taken to concrete the pump-winze, which was recently holed from the 18th level to surface. Later the electric cables and steam and water lines will be moved from A shaft and installed in this pump-winze.

The Inspiration mine is producing about 10,500,000 lb. of copper per month, substantially in excess of the original estimate of 120,000,000 lb. per year. It is estimated that the company will earn during the current year sufficient to pay for all its mining claims, a total of \$18,000,000. Work on the erection of the additional concentrator sections will soon be under way, and they should be at work in the early part of winter. The mine

appears to be in excellent shape for the delivery of the added tonnage. Recently a record hoisting performance was established, when the mine produced 19,700 tons in 24 hours. This amount of ore is more than the 20 mill-sections would ordinarily handle, but at the rate of present increase it is conceivable that the mine might have to maintain a daily production of 19,000 tons.

Considerable attention is being given to the question of water reclamation for the mill-supply of the Inspiration, the arrangement of the tailing-dams being convenient for the purpose. It requires a good deal less power to pump water from the tailing-dams to the head of the mill than is required in pumping water from the wells in the flat below the smelter. Consequently the company makes every effort to return all available water instead of letting it run to waste. In order to clarify the water that is being returned from the lower dams, preparations are being made with the view to excavating a large canal-like opening in the surface of the material stored behind the Ellison canyon dam, which has now reached the limit of its tailing capacity. This canal, which will probably be made by means of a suction-dredge, will be used as an immense settling-tank that will allow the water to overflow in almost clear condition.

The New Cornelia is pushing construction work rapidly and Ajo is developing into a real city. Two distinct types of dwellings are noticeable, temporary tent-houses, and those being constructed of stone, brick, and cement, for permanence. Streets are being graded, houses, stores and offices erected, and parks decorated; the grass is growing, and the temporary nature of the town is gradually disappearing.

The United Verde Copper Co. has in progress the sinking of an interior three-compartment shaft from the 1000-ft. level, where the main adit, with standard-gauge tracks, connects with the underground workings, and through which the ore is hauled to the smelter at Clarkdale. The planned collar of the new shaft is close to the adit, and it is to sink to 2200 ft. The equipment ordered includes an Allis-Chalmers hoist, with Westinghouse electrical equipment. It is a geared double-drum hoist, driven by an electric-motor set, adapted to receive alternating current, and to furnish direct current to the hoist-motor and controlling apparatus. The hoist will have a speed of 1900 ft. per minute, and will operate to a depth of 3000 ft. The sheaves will be placed at the 800-ft. level, and the ore will be dumped by automatic dumping-cradles between the 800 and 900-ft. levels, then conveyed through chutes to storage-bins on the 1000-ft. level, a 1500-ton storage-bin on each side of the adit being equipped with loading devices. These plans were developed under the direction of Will L. Clark, general manager, and R. E. Tally, superintendent.

Plans to use steam-shovels in stripping the surface orebodies at the United Verde in the vicinity of the old smelter site are under consideration. These plans involve the removal of 80 to 100 ft. of overburden, making it practicable to mine the ores from the surface down, instead of by underground operations adjacent to the fire area.

The capacity of the Miami mill will be increased to permit a monthly yield of 5,000,000 lb. of copper. This increase, however, is not expected to become effective until early in 1917. It will involve new equipment and power-plant, work on which has already been started. There has been put into operation a 100-ton experimental mill for Miami's low-grade ore from which an extraction of about 80% has been made. With an output of 4,600,000 lb. in May, the Miami established a new high record. The cost approximated 8.7c. per lb.,

on the east and north. It is not known whom the engineers represent in this particular instance or what the examination signifies. The Ajo Consolidated is one of the oldest properties in the South-west. According to reports, more than 15,000,000 tons of ore is blocked-out. The ore is said to average about 2% as compared with 1.4% at the New Cornelia, and besides this, there are some patches of rich ore.

The Big Jim at Oatman has started something new, a visitor's day, set-aside by the management to permit people to see things for themselves; they are allowed to sample the mine anywhere they wish, and form their own conclusions. Mining men in the camp are made welcome, and the invitation also includes brokers, promoters, assayers, newspaper representatives, and the public in general. Many have taken advantage of the invitation.

It was with an entirely new staff that the Tom Reed mine, also at Oatman, started operations for June, when the new administration took the place of the officials whose retirement was announced recently. The following are the officers: pres., W. P. Moerdyke; vice-pres., Chas. Mushrush; superintendent, E. M. Rabb; consulting geologist, Ellis Mallery; resident agent, J. C. McCabe; master mechanic, J. W. Hayes; mine-foreman, A. C. Hoffman; engineer, Victor A. Light. Mr. Moerdyke announces a program of economy and efficiency in all departments. A complete examination will be made of the reserves and physical condition of the mine. Mr. Moerdyke states that the career of the Tom Reed is all before it, past performances being slight in comparison to the future. Yet from an extraction of slightly more than \$6,000,000 from the Ben Harrison claims, dividends aggregating \$3,000,000 have gone to the shareholders. In the past, information has not been obtainable from the company officials, but it is admitted that the Black Eagle shaft, beyond the Telluride and Combination, has 600 ft. in ore on the 565-ft. level. This is claimed to be merely the apex of the ore shoot, and it is hoped that it may prove as great a deposit as the United Eastern, though not as yet developed to the same extent. It exceeds the Ben Harrison itself and is now known to be the biggest orebody in the mine. The average for the entire known portion is said to be \$20 per ton.

THE TIN produced annually by the world can be taken in round numbers at 100,000 tons worth \$1000 per ton, or a total of \$100,000,000. Though it is not generally appreciated, this is worth as much as the world's normal output of zinc and lead, each of which at 1,000,000 tons per annum, worth approximately \$100 per ton, is also valued at \$100,000,000.

LEAD produced by the Bunker Hill & Sullivan Co. during 1915 was 74,584,711 lb., which is approximately equal to the output in copper of the Calumet & Hecla Co. The lead was sold for 4 7/8c. per lb., while the copper brought 18.11c., or nearly four times as much.



MAP SHOWING JEROME AND CLARKDALE.

against a January cost of over 9c. Miami's normal monthly production may now be regarded as approximately 4,500,000 lb. copper. Estimating the June yield at this figure, the output for the first half of 1916 is about 25,300,000 lb., produced at an average cost of slightly less than 9c. per lb. On the basis of 4,500,000 lb. per month, the yield for the concluding half-year should approximate 27,000,000 lb., or close to 53,000,000 lb. for the year.

Calumet & Arizona engineers, some of them the same that sampled the New Cornelia, are sampling the Ajo Consolidated property, which adjoins the New Cornelia

An Extra-Lateral Problem

By Robert M. Searls

A recent decision of the Supreme Court of Montana throws light on a new complication in the law of extra-lateral rights as applied to veins joining on the dip. The questions decided are an extension of those principles outlined in the *Ajax-Hilkey* case (31 Colorado, 131, 72 Pacific 447) and the *Del Monte-Last Chance* case (171 United States, 55), but disagree in part with the ruling in the *Stemwinder* cases. They will be best understood by reference to the following diagrams, which are copied from the decision as reported in 156 Pacific, 409.

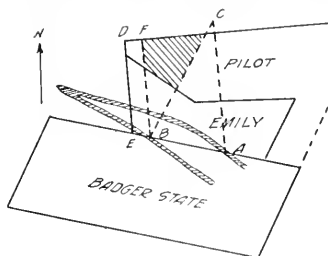


FIG 1

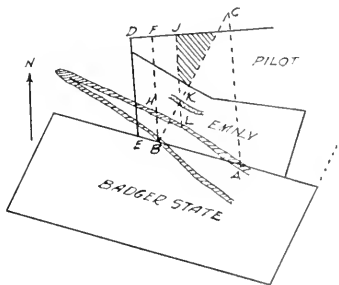


FIG 2

The plaintiff in this case owned the Badger State and Emily claims, the defendant owned the Pilot claim. The two lodes shown on the diagram apexed in both the Badger and Emily claims but united on the dip at the point *K* and thereafter continued as one lode underneath the Pilot claim. The order of seniority of location was (1) Badger, (2) Emily and (3) Pilot. The southerly of the two veins shown was the discovery vein for both the Badger and Emily claims. Suit was brought by the owner of the Badger and Emily claims to enjoin extraction by the Pilot owner of ore lying beneath the Pilot claim and within the limits of the extra-lateral plane of the Badger-Emily lodes. The question raised on appeal was as to the boundaries of the plane to which the plaintiff might lawfully claim title and hence obtain an injunction.

The trial court awarded an injunction prohibiting the Pilot owners from mining upon the portion of the vein

beneath the Pilot claim bounded by planes drawn through the Emily west end-line and the Badger States east end-line projected north indefinitely. From this decision the defendant appealed, claiming that the plaintiffs had no right to that portion of the plane lying within the Pilot boundaries and bounded by the lines *BF* and *BC* (Fig. 1). In this contention they were sustained by the appellate tribunal on the original appeal, but on rehearing the injunction was modified so as to exclude as not belonging to the plaintiff only that portion of the plane lying below the junction *K* and bounded by the lines *KT* and *KC* (Fig. 2).

The line of reasoning adopted by the Supreme Court in its final decision on rehearing was, briefly stated, as follows: (1) If two veins unite on the dip, the owner of the senior vein takes that portion of the lode below the union (Revised Statutes Sec. 2336); (2) therefore his ownership below that point should be governed by the boundary planes of the senior vein in the absence of any other consideration; (3) if the reasoning stopped here, the south or Badger vein, being the discovery vein for both claims would be bounded extra-laterally by planes passed through *BC* and the Badger State east end-line as to the Badger claim, and by *BF* and *DE* as to the Emily claim, leaving the shaded portion in Fig. 1 not subject to ownership by the plaintiffs; (4) but the north or Emily vein is a secondary vein, apexing within the Emily claim, and the owners of the Emily are entitled to an extra-lateral right thereon measured by the length of free apex of such vein lying between the end-lines of the Emily claim (*Ajax Mining Co. v. Hilkey*, 31 Colorado, 131, 72 Pacific, 447), that is, it is bounded by planes passed through *ED* and *AC*; (5) this right however will be limited below *K*, the junction of the Emily and Badger veins, which is inside the Emily vertical boundaries, by the boundaries of the senior Badger right wherever it conflicts; (6) but as demonstrated in proposition (3) the Badger right of itself does not include the shaded portion of Fig. 1; (7) It follows that the secondary Emily vein has an extra-lateral right *BFJL* (Fig. 2), which is independent of the Badger right and is found by subtracting the Badger right from what would be the Emily extra-lateral if the Badger did not exist, (*Lindley on Mines*, Sec. 594, p. 1394); (8) therefore the plaintiffs, who are entitled to an extra-lateral right on both the Badger and Emily veins, should be awarded an injunction against the Pilot owners preventing the latter from working any part of the extra-lateral segment except the portion comprised within the shaded portion of Fig. 2.

It should be noted that in fixing the eastern boundary of the extra-lateral right to the north or secondary vein at *AC* instead of *BF* the Court departed from the rule of the *Stemwinder* cases but is in accord with the doctrine of the courts as laid down in *State ex. rel. Anaconda C. M. Co. v. District Court* (25 Montana, 504, 65 Pacific 1020) and in the *Del Monte* case (171 U. S. 55). In other words, within the boundaries of the end-line planes of the claim, the secondary vein is given an extra-lateral right based upon its length of free apex

and is not limited by the boundary planes of the discovery vein.

The accident of union of the two veins became important only because the right to the united vein below the point of union was the subject of inquiry. The north vein, having no extra-lateral as against the senior south vein wherever there would be a conflict in extra-lateral rights below that point of union, no right as against third parties could be asserted by the north vein owner at such conflict unless the senior right could prevail, even though ownership of the junior apex would have established the right if the conflict had not existed. A right cannot be predicated upon a trespass.

The case is a curious one in that, from the standpoint of the Emily owners the less apex they had on their discovery vein, the better it was for them. If the veins had crossed both end-lines they would have lost their right altogether because the end-lines were not parallel and diverged in the direction of dip. Had the discovery vein been more nearly coincident with the south side-line and hence shorter, the excluded triangle *JKC*, would have been still smaller and they could have claimed a larger segment under their secondary vein extra-lateral. It is an example of the complications into which the law governing extra-lateral rights sometimes leads.

Lead Salts, Alkalinity, and Solvent Power of Cyanide for Gold

By H. R. Edmonds

*In the course of experimental work on leaching roasted gold ore, special attention was given (a) to solutions foul with soluble sulphides, and (b) to solutions in which the sulphur was mainly converted into thio-cyanates and thio-sulphates, and none was present as sulphide.

The appearance of soluble sulphides in working cyanide solutions is of unusual occurrence, and was, fortunately, only a temporary incident, soon obviated by providing facilities for quicker draining and thus increasing the leaching rate of vats, but the thio-cyanates and thio-sulphates were always present in quantity varying with the sweetness of the roast. As the treatment of roasted ore by leaching is somewhat unusual, it may be as well to state that satisfactory extractions are being obtained, the main desiderata being rapid leaching, and either double treatment, or turning over the ore in the vats, that is, digging down into the sand as far as possible to allow of its exposure to the air.

SOLUBLE SULPHIDES. The general impression seems to be that if these ever occur, they are extremely unstable, and disappear on decanting from one vessel to another, if they are not already precipitated by the zinc always present in working cyanide solutions. A series of tests showed that their proneness to oxidation has been greatly exaggerated, that the presence or absence of protective alkalinity has little effect on their oxidation, but that soluble carbonates have a tendency to hasten oxidation. A much more effective oxidation of soluble sulphides takes place in the leaching vats; these after thorough draining have a strong oxidizing tendency on solution subsequently passed through—partly due to the air present in the drained vats, but probably largely assisted by the presence of ferric oxide in the ore. The use of ferric oxide in freeing town gas from H_2S is well known. Treatment with lead acetate was, of course,

quite effective in precipitating all soluble sulphides, but it remained to be seen what effect such treatment would have on the solvent power of the solution for gold.

EFFECT OF LEAD SALTS IN CYANIDE TREATMENT. This has been investigated by Clemmell,¹ Clevenger,² Holt,³ and others, but more particularly in reference to the treatment of silver ores. The general conclusion appears to be that its use in silver-ore treatment is decidedly beneficial, and also to a lesser extent in gold ore, but that it is necessary to add the correct quantity as an excess may be injurious; no specific rule, however, is given for determining the correct amount, nor is any reason advanced as to why an excess may prove injurious.

Experiments made on the roasted ore discussed in this article showed that the addition of CaO improved extraction—adding lead acetate in addition to CaO gave a further improvement, but the best extractions were obtained by adding acetate and omitting lime, at a cost, however, of greater cyanide consumption. It should be noted that in these tests no soluble sulphides were detected either before or after treatment.

Somewhat different results were obtained by two tests in which roasted ore was agitated with solution foul with soluble sulphides. It would appear that under the conditions, in a solution containing little or no protective alkali, the use of acetate in just sufficient quantity to precipitate soluble sulphides, is beneficial, but may be injurious in the presence of much CaO , especially if the acetate be in excess. The effect of adding acetate to solutions containing soluble sulphides is, that of the precipitated sulphide be removed by filtration, a considerable increase in solvent activity ensues, but that the presence of PbS renders solutions containing any protective alkalinity almost incapable of dissolving gold, even

*Abstract from *Monthly Journal* of Chamber of Mines, Kangaroo, Western Australia.

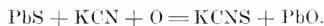
¹*Eng. & Min. Jour.*, 80, 28, 1912.

²*U. S. P.*, Oct. 14, 1903.

³*M. & S. P.*, Apr. 17, '09.

power is only imperfectly restored by neutralizing the protective alkalinity.

The reaction assumed to take place between PbS and KCN is a reducing one



To ascertain how far the above reaction proceeded, a weighed quantity of freshly precipitated PbS was added to a freshly prepared solution of NaCN of definite strength, and agitated for 16 hours with excess of air and with high and low protective alkalinity (CaO). It was found that with low P.A. all the PbS was apparently oxidized, but that much remained unoxidized with high P.A. Strong traces of NaCNS were formed with low, and less with high P.A., but in neither case had any large proportion of the sulphur contained in the PbS, combined with NaCN to form NaCNS. With high lime content much remained unaltered, and with low lime the dissolved air had probably largely oxidized the sulphide to sulphate. In neither case was the formation of NaCNS commensurate with the weight of PbS added; this was shown by titrating the solution for NaCN and observing the loss due to formation of thio-cyanates.

The general results of several tests on the effect of adding lead acetate to solutions containing soluble salts, PbS removed by filtration or left in, and P.A. present or neutralized, are materially different from those obtained by treating roasted ore with cyanide solutions containing CaO, lead acetate, etc.

Another lot shows the effect of addition of acetate to solutions prepared from NaCN and pure CaO, and to mill solutions free from soluble sulphides, but containing other sulphur compounds, as thio-cyanates, thio-sulphates, etc., ferro-cyanides being present in traces only. It is remarkable that the addition of so small a quantity of lead acetate as 0.0025% should have so great an adverse influence on solvent activity, such influence being shared by PbS and PbO. That alkali increases the effect of such compounds is doubtless because it increases their solubility, but it is certainly remarkable that similar results should not occur when treating ores containing notable amounts of galena, cerussite, etc. Galena, for instance, is a frequent constituent of ores in the Menzies district, its presence usually indicating high gold-content; or lead compounds are also present in many of the oxidized ores there, but they give no special trouble in cyanidation.

Further experiments on the effect of varying alkalinity, both on mill solutions, containing—as before—thio-cyanates etc., and on pure solutions, showed that neutralization of protective alkalinity in some cases increases solvent activity and addition of CaO depresses it; and if the total alkalinity of mill solutions is neutralized, using phenol-phthalein as an indicator there is a large increase in their solvent activity.

JUDGE GARY'S ADVICE. To employers of labor I would say: Treat your men right; treat them justly and liberally. To employees I would say: Loyal, efficient service is sure to be rewarded. Do not permit outsiders to in-

fluence you to act contrary to your own interests. To both employer and employee, I would emphasize the fact that each must rely upon the other for success; neither is independent of the other; they succeed or fail together.

Definition of the Term Potash

*To meet the numerous inquiries that have been addressed to the U. S. Geological Survey regarding the exact meaning of the terms 'potash,' 'actual potash,' and 'potassium,' the following explanation is given:

The element potassium, represented by the symbol K, is the basis of all potash salts or compounds. This substance is a metal; that is, it possesses metallic properties. To prevent rapid change it must be kept from air and water, with both of which it combines with great avidity. Combined with oxygen it forms potassium oxide, represented by the symbol K_2O , known as potassa, but popularly as potash. In estimating the quantity of potassium in the different products of the Stassfurt (Germany) deposits, this compound, K_2O , is employed as a standard, the object being to establish a basis of comparison for all potassium salts. Among chemists as well as laymen there has grown up the practice of using for this standard the term 'potash.' When only the term 'potash' is used in speaking of potash products, it is understood to refer to the potassium oxide (K_2O) present. As a matter of fact, however, potash salts are not sold in the form K_2O , but as the sulphate or the chloride. By the term 'potassium sulphate' is meant potassium (K) combined with the acid radicle of sulphuric acid (SO_4), or potassium oxide (K_2O) combined with sulphur trioxide (SO_3), making the compound K_2SO_4 . By potassium chloride is meant potassium (K) combined with another element, chlorine (Cl), and represented by the formula KCl.

In the following table are given the percentages of the element potassium, and also of the combination known as potash in or obtainable from the common potassium compounds and minerals:

Name and symbol Element:	Percent- age of potassium (K)	Chemical equivalent in terms of potash (K_2O)
Potassium—K	100	120
Potassium salts or potash salts:		
Potassium chloride (mineral syl- vite)—KCl	52	63
Potassium muriate (same as chlo- ride)		
Potassium sulphate— K_2SO_4	45	54
Potassium nitrate (saltpeter)— KNO_3	39	47
*Potassium carbonate— K_2CO_3	57	68
Potassium hydrate or caustic pot- ash—KOH	70	84
Potassium cyanide—KCN	60	72
Stassfurt minerals:		
Carnallite— $\text{KMgCl}_2 \cdot 6\text{H}_2\text{O}$	14	17
Kainite— $\text{MgSO}_4 \cdot \text{KCl} \cdot 3\text{H}_2\text{O}$	16	19
Sylvite (potassium chloride)—KCl	52	63

*The term 'potash' is often applied to this compound.

*Abstract from 'Potash Salts, 1915,' by W. C. Phalen.

The Ketchikan District, Alaska

By Emil Edward Hurja

Ketchikan's copper mining industry has taken a new lease on life, by help of the higher price for the metal. Six properties, all of them on Prince of Wales island, are shipping regularly. The total tonnage per month from these six properties amounts to 12,000 tons, with odd shipments from prospects and mines undergoing development. Three hundred men are employed.

The district is still in the development stage. Examinations are being made in many localities, the most interesting being that of the Alaska-Gastineau party in charge of F. B. Hyder, of Juneau, Enoch Perkins and O. P. Rogers assisting. This party has been examining properties in and about Ketchikan since May 1 and during the six weeks following visited nearly all of the prospects in the district. Some options have been taken and further inspection of some of the claims is being made. Other exploratory work is that of the Lakinaw-Tagish company, in charge of J. L. Harper.

The principal mining is being done by the Granby Consolidated Mining, Smelting & Power Co. on the Mamie and It claims. Both of these claims, together with a third, the Dean, on which work has been suspended, were taken up by the Granby company in 1913 on working options. Both claims have since been paid for by ore taken out during the course of development. The work of the company is in charge of Nelson W. Sweetser. W. J. Coulter is foreman at the Mamie mine, and Bert Ross at the It. The Granby holdings are on Kasaan peninsula, near Hadley, 30 miles north-west of Ketchikan. The Mamie mine, which is shipping at the rate of 6000 tons per month to the Anyox smelter, has 2500 ft. of workings. Eighty-five men are employed. A Riblett aerial tram 7200 ft. long carries the ore from the mine to the bunkers at Hadley, where ocean-going scows are loaded and conveyed by tugs to the smelter. The ore, chalcopryite in a silicious and magnetite gangue, occurs in large lenses. The largest lens is 300 by 100 ft. The It, upon which the final payment of a \$50,000 purchase

price was made on May 1, has shipped 15,000 tons during the past year. Thirty men are employed. The work of the past year consists of 1000 ft. of drifts and raises and 1500 ft. of diamond-drill holes. Diamond-drilling is still going on at the It and the Mamie to determine the extent of the orebodies. The It is shipping at the rate of 1000 tons monthly.

The Mt. Andrew mine, at the head of Kasaan bay, 27 miles from Ketchikan, is shipping 1500 tons per month.



TUG 'COMMODORE' LEAVING HADLEY WITH SEA-GOING BARGE LOADED WITH 2500 TONS OF COPPER.

The group consists of 21 claims, owned by the Mt. Andrew Mining Co. of New York. The claims were bonded on June 1, 1915, by W. J. Rogers, who is now directing the mining operations. The adits aggregate 7000 ft. Total shipments from the property amount to 90,000 tons. The principal development work is an adit that increases the depth on the orebody from 150 ft. to 460 ft. This 'tunnel' lacked 80 ft. of being the necessary 1560 ft. in length to reach ore on June 16. The deposit contains magnetite and chalcopryite, with some gold and silver. Twenty-nine men are employed. New buildings will be started soon. The property is situated at an elevation of 1300 ft. above sea level. The ore is conveyed to the dock in a Riblett aerial tram 4200 ft. long. Engineers of the Alaska-Gastineau company are conducting an examination of the property. The Mt. Andrew mine is on the border of the same eruptive as the Mamie. Axel Carlson is superintendent.

Rush & Brown, on their claims at the head of Kasaan bay, are mining from a contact metamorphic lens of magnetite ore containing chalcopryite, and shipping at

the rate of 500 tons monthly to the Anyox smelter. They are employing 25 men. Recent work on the Rush & Brown property consists of a winze and drifts from the winze. The orebody has been picked up below a fault. The lowest level on which work is being done is 250 ft. below the surface. A narrow-gauge railroad connects the mine with the bunkers and dock at Kasaan bay. On May 29, Rush & Brown shipped 800 tons of ore on the ship *Granby*. John Wilcox is superintendent.

The Goodro property, on Karta bay, one mile south of the Rush & Brown mine, has 700 tons of ore ready for shipment. No new work has been done on this claim. Ore is being broken from the 100-ft. level to the surface. Ten men are employed. The ore is bornite disseminated in gabbro. It also carries some native gold.

Development work is being carried on steadily on the Valparaíso group of gold claims near Dolomi. The group is operated by the Princeton Mining & Milling Co., with B. A. Eardley as manager. Ed. C. Morse has charge of the 10-stamp mill, together with a Chilean mill.

The Lakinaw-Tagish Co., of which J. L. Harper is manager, has taken options on the Westlake-King property, known as the Portland group, on the north arm of Moira sound, as well as on the Cymru mine, in the same locality. On June 2 a bond was taken on the Portland group, upon which \$6000 worth of work has been done. No shipments of ore have been made as yet. Assays show zinc, lead, copper, and silver, in a fissure-vein 4 ft. wide. The maximum depth attained is 130 ft. As zinc is the principal ingredient of the ore, shipments will be made to Oakland, Cal., where special treatment will be given. At the northern end of the property is a gold-lead deposit, from which shipments are planned to the Trail, B. C., smelter. Ore mined from the Portland group is conveyed 1000 ft. on an aerial tram to Mineral lake, taken across the lake $1\frac{1}{2}$ miles with scows to connect with the Cymru tramway. Five hundred tons of ore has been mined and is ready for shipment by July 15. A compressor plant and air-drills will be available soon, and the tram extended around Mineral lake to avoid the water-haul. Ten men are employed.

On the Cymru property a shaft has been sunk 100 ft. A three-drill compressor is in operation, as well as a gasoline hoist. A one-mile narrow-gauge track with gasoline locomotives connects the mine with tide-water. Three hundred tons of ore will be shipped to the smelter at Tacoma early in July.

In the Portland Canal district, everything is quiet. The season has been backward and all exploratory work has been retarded. The Alaska-Gastineau company has an option on the Missonri group of claims, on which some work will yet be done. H. R. Plate, representing the Hermosa Issues Co. of New York, has given up his bond. Access to these prospects, which are on the British Columbia side of the line, is obtained through the Salmon River valley.

The Alaska Venture Syndicate, of London, a subsidiary of the Great Boulder Proprietary, of Western Australia, has suspended work on the Old Glory claims

at Smuggler's cove on Cleveland peninsula, 25 miles north of Ketchikan. The original owners of the claims were Martin Bugge and associates. Development work done on the property after the spring of 1914 consists of surface stripping and prospecting. Improvements on the claims aggregated \$150,000. The work is held in abeyance because of the War.

It is reported in Ketchikan that Catlin, owner of the Sunshine silver-lead property on Cholmondeley sound, is to resume work soon. Over 150 tons of ore is on the dump, ready to ship.

The It Mining Co., of which H. C. Strong is president and J. L. Barber secretary, is planning to develop the Gold Stream property, consisting of the Gold Spring and Gold Stone claims, on Gravina island, opposite Ketchikan, three miles from the town. Work on the lode, which contains gold, consists of 150 ft. of shaft and 300 ft. of tunnel work.

W. H. Gilmore and Fremont King, owners of the Sea Level property, near Ketchikan, have bonded it to Carl B. Lancaster, of Seattle, with whom are associated C. H. Black and Carl Strong. The property shows a vein varying in width from 2 to 10 ft. and carrying free-milling gold ore. The Sea Breeze claim, which adjoins the Sea Level property on the east and carries a continuation of the Sea Level vein, will be opened up through the Sea Level workings, which have been unwatered. Four men are employed under Carl B. Lancaster. The workings of the Sea Level run to within 150 ft. of the Sea Breeze line. A small hoist is in use. A Fairbanks-Morse semi-Deisel 25-hp. engine and a Fairbanks-Morse compressor have been bought and will be on the property when the work is farther advanced. The Sea Level has a 30-stamp mill built in 1907 but not used for many years.

The Goo Goo group of gold claims, owned by Richard Nuekolls and associates, and situated near the Sea Level, have been examined by Alaska-Gastineau engineers. Nine tons of samples were taken on June 15.

M. M. Reese has discontinued work on the Dunton property near Hollis. Development at the Ready Bullion continues. Exploratory work on other prospects in the same vicinity is being carried on steadily. But little more than assessment work has been done on the promising Lucky Nell group, situated 8 miles from tide-water at Hollis. Thirty tons of this ore yielded \$46 per ton in 1913. Since that time no shipments have been made. Polson & Jekis are continuing work on their copper and gold property at McLean arm, 40 miles from Ketchikan. Two chalcopyrite deposits are exposed.

Mining on the west coast of Prince of Wales island, which also is tributary to Ketchikan, is based almost entirely on copper ore. The oldest regular producer in the district is the Jumbo, near the head of Hetta inlet. This mine is operated by the Alaska Industrial Co., of which Senator Charles A. Sulzer is active manager. Shipments are being made regularly at the rate of 150 tons per month. The ore, chalcopyrite in lime, epidote, and garnet gangue, is practically neutral and is easily smelted. Shipments are made to Tacoma. A total depth of

700 ft. has been made possible with connected adits. From the lowest a winze has been sunk 200 ft. From this depth stoping is now being carried on. The winze is being sunk another 100 ft. to connect with a lower adit. Surface exploration of the western end of the Ambo deposit has been encouraging. Senator Sulzer expects

Senator Sulzer is erecting an Allis Chalmers table mill for the reduction of barite from a deposit that he discovered near Lime point. Several hundred tons of this product was shipped last year, with satisfactory results, so Senator Sulzer plans to treat the ore at home. The deposit is over 100 ft. wide. — Sweet brothers are oper-



STOPE IN THE TI MINE, KASAN, PUNJUT.

to open up that end of the orebody next, building short aerial trams to connect with the main Lascien aerial tram, which carries the ore a distance of two miles to the bunkers. A saw-mill has been purchased and new quarters and other buildings will be built. W. L. Moore, formerly with the Alaska-Juneau at Juneau, is superintendent of construction. Robert Pollock has been made mine superintendent.

ating the mine of the North and Development Co. at Big Harbor, under a bond. A shipment of 150 tons was recently made to the smelter at Tacoma. The ore is a massive perite containing no pyrite. Assays of ore from the latter of a few shipments yielded 60 to 65 percent barite. The head of K. etc. let's us see the first 87.0 percent. This property is owned by C. A. Sulzer, of P. A. etc. recently over 100 ft. Big Harbor property is owned

ed the Gould claims on the south end of Suquan island. He has a small force of men employed in exploratory work.—W. H. Link and J. W. Rickenback, of Seattle, arrived recently on the *Curacao* and have resumed development work on their property adjoining the Red Wing at Copper City. John Spaeth, George Bureh, and John Wileox have prospected and made new locations of copper claims at Hunter's bay.

Prospecting has been given an impetus by the successful operation of a number of properties. The district can stand prospecting, however, for the total area of the Ketchikan mining district is 9370 square miles, of which 2800 square miles is represented by Prince of Wales island alone.

COPPER is said to have derived its name from the island of Cyprus, whence the Romans obtained their supplies of copper ore.

Explosives

Explosives are classified by the Bureau of Mines into four groups: ammonium-nitrate explosives; hydrated explosives; organic-nitrate explosives other than nitroglycerine; and nitro-glycerine explosives.

Ammonium nitrate itself is not an active explosive, but under particular conditions, such as a strong detonator, is capable of explosive decomposition. When pure it has no practical application for blasting, but needs the addition of 'sensitizers.' These sensitizers may themselves have explosive qualities, as nitro-glycerine or nitro-cellulose, or they may be non-explosive such as resin, sulphur, flour, sugar, oil, paraffin, or coal. A large number of commercial explosives are included in the ammonium-nitrate group.

Hydrated explosives are those that depend largely

Russian Measures

QUANTITY	EQUIVALENT	LOGS.
<i>vershok</i>	1750 inches 44.45 mm.	0243 0380 1647 8718
<i>Russ. ft.</i>	100 Eng. ft. 03048 meter	0000 0000 9484 0158
<i>arshine</i>	1600 <i>vershoks</i> 2800 inches 23333 feet 07778 yard	1204 1200 1447 1580 0367 9768 9890 8555
<i>sagene</i>	300 <i>arshines</i> 700 feet	0477 1213 0845 0980
<i>verst</i>	50000 <i>sagene</i> s 350000 feet 066288 mile 106680 Kilom.	2698 9700 3544 0680 9821 4341 0028 0846
<i>meter</i>	140610 <i>arshines</i> 046870 <i>sagene</i> 3937079 inches 328083 feet 109363 yards	0148 0162 9670 8948 1595 1741 0515 9830 0038 8716
<i>kilometer</i>	468700 <i>sagene</i> s 09374 <i>verst</i> 062137 mile	2670 8948 9971 9249 9797 3499
<i>sq. arsh.</i>	25600 <i>sq. vershok</i> 54444 <i>sq. ft.</i>	2408 2400 0735 9536
<i>desiatine</i>	240000 <i>sq. sagene</i> 27001 acres	3380 2112 0431 3792
<i>acre</i>	888857 <i>sq. sagene</i> 037036 <i>desiatine</i> 4356000 <i>sq. ft.</i>	2948 8320 9568 6208 4639 0879
<i>sq. mile</i>	22758 <i>sq. verst</i> 25900 <i>sq. Kilom.</i>	0357 1318 0413 3002

QUANTITY	EQUIVALENT	LOGS.
<i>vedro</i>	10000 <i>Krushkas</i> 12299 liters 75051 cu. inches 3249 U.S. gal. 27067 Imp. gal.	1000 0000 1089 8698 2875 3562 0511 8026 0432 4471
<i>U.S. gal</i>	030775 <i>vedro</i> 231.00 cu. in. 376543 liters	9488 1974 2363 6120 0578 1164
<i>Imp. gal.</i>	03695 <i>vedro</i> 277274 cu. in. 454369 liters	9567 5529 2442 9091 0657 4086
<i>pood</i>	40.00 <i>funt</i> s 36113 pounds 163805 Kg.	1602 0600 1557 6636 1214 3272
<i>100 poods</i>	16056 short ton 16122 long ton 16380 met. ton	0256 6336 0207 4156 0214 3272
<i>funt</i>	09028 pound 409503 grams	9955 5916 2612 2570
<i>zolotnik</i>	0.33333 lot 96.000 doli's 42659 grams 65833 grains 2743 dwt 013715 Troy oz. 015047 Avoir oz.	9522 8744 1982 2712 0630 0107 1818 4442 0438 2330 9137 2030 9177 4661
<i>doli</i>	44435 mg. 0686 grains	1647 7252 9836 3241
<i>cord</i>	12800 cu. ft. 037317 cu. sag.	2107 2100 9571 9067
<i>cu. sagene</i>	34300 cu. ft. 26797 cords	2535 2941 0428 0862

upon the cooling effect of the water of crystallization to reduce the flame temperature for their safe use in coal mines. The hydrated salts employed to furnish the water of crystallization are Epsom salt or potassium alum. The hydrated explosives contain nitro-glycerine as the principal explosive ingredient, and most of them also contain ammonium nitrate. Only a few commercial explosives are in this group.

The third group, the organic nitrates, includes explosives containing 'nitro-starch' (starch nitrate), or a similar organic nitrate as the characteristic ingredient. Starch is a carbo-hydrate, of the composition $C_6H_{10}O_5$. Nitro-starch explosives are known to mining men as being the explosive sold by one or two manufacturing companies in particular. When used alone, nitro-starch liberates the dangerous carbon-monoxide gas, but by the addition of oxidizing compounds in the manufacturing

this disadvantage is reduced. The Nevada Consolidated Copper Co. uses a good deal of nitro-starch explosive in its open-pit blasting.

The fourth group, nitro-glycerine, includes all explosives whose characteristic ingredient is nitro-glycerine and which are not included in the class of 'hydrated explosives.' Various ingredients are used with the nitro-glycerine, either an absorbent neutral base such as infusorial earth for the making of 'straight dynamite,' or the active gum-cotton which dissolves in the nitro-glycerine to make gelatine. A great many of the commercial explosives belong to the nitro-glycerine group.

THE STEEL HELMETS used in the French army to protect the heads of soldiers are only one millimeter (1/25 inch) thick and are surprisingly light. They are made of the best half-hardened sheet steel.

and Equivalents

(By courtesy of Edward L. Stenger.)

QUANTITY	EQUIVALENT	LOGS.
<i>Avoir. lb.</i>	1.10767 <i>Funts</i> 45359 <i>grams</i>	0044 4104 2656 6654
<i>ton</i> 2000 <i>lb.</i>	55382 <i>poods</i> 907185 <i>Kilogram</i> 2916600 <i>Troy oz.</i>	1743 3686 2357 6958 4464 8769
<i>ton</i> 2240 <i>lb.</i>	62028 <i>poods</i> 101605 <i>Kilogram</i>	1792 5878 3006 9150
<i>met. ton</i> 1000 <i>Kg.</i>	61047 <i>poods</i> 220462 <i>pounds</i> 11023 <i>short ton</i> 23842 <i>long ton</i>	1785 6662 3343 3338 0042 2998 9993 0818
<i>Kilogram</i>	220462 <i>Avoir. lb.</i> 321507 <i>Troy oz.</i>	0343 3338 1507 1905
<i>gram</i>	22.50 <i>dolis</i> 023442 <i>zolotnik</i>	1352 1825 9369 9893
<i>grain</i>	1458 <i>dolis</i> 648 <i>mg.</i>	0163 7490 1811 5750
<i>Troy oz.</i>	72914 <i>zolotnik</i> 69938 <i>dolis</i> 109714 <i>Avoir. oz.</i> 48000 <i>grains</i> 3110348 <i>grams</i>	0862 8109 2845 0821 0040 2620 2681 2412 1492 8090
<i>£</i>	48665 <i>dollars</i> 3459 <i>roubles</i> <i>equivalents</i> <i>below based upon</i> <i>these values.</i>	0687 2167 0975 8452
<i>Troy oz.</i> <i>pure gold</i>	£ 424773 \$ 206716 R ⁵ 40179	0628 1569 1315 3741 1603 9991
<i>cu. sagene</i> <i>gravel</i>	1200 <i>poods</i>	3079 1812

QUANTITY	EQUIVALENT	LOGS.
<i>cu. yard</i> <i>gravel</i>	3411 <i>pounds</i> 9445 <i>poods</i>	3532 8817 1975 2181
<i>doli-gold</i> <i>per 100 pood</i>	d 14564 <i>per 100 pood</i> \$ 00295 " " R ⁵ 00574 " " d 1376 <i>per cu. yd.</i> \$ 00279 " " R ⁵ 00542 " " 000886147 <i>Troy</i> <i>oz. per long ton</i> 000079120 <i>Troy</i> <i>oz. per short ton</i>	0163 2807 8469 8220 8758 9119 0138 4988 8445 0401 8734 1300 6947 5057 6898 2865
<i>doli-gold</i> <i>per cu. sag</i>	d 0.1146 <i>per cu. yd.</i> \$ 0002322 " " R ⁵ 0004268 " "	9059 3504 7365 8917 7630 1997
<i>oz. Troy</i> <i>long ton</i>	112848 <i>dolis/100 pood</i>	3052 4943
<i>oz. Troy</i> <i>short ton</i>	126390 <i>dolis/100 pood</i>	3101 7135
<i>rouble</i> <i>per pood</i>	\$ 31912 <i>a long ton</i> £ 65576 " " £ 118-2d \$ 2849 <i>a short ton</i> £ 5855 " " 5£-178-1d	1503 9593 0816 7426 1454 7401 0767 5234
<i>rouble</i> <i>long ton</i>	\$ 05145 <i>a long ton</i> £ 01057 " "	9711 3715 9024 1548
<i>£ per</i> <i>long ton</i>	R ⁵ 015249 <i>a pood</i> \$ 43415 <i>a short ton</i>	9183 2574 0637 9987
<i>Kopeck</i> <i>per pood</i>	£ 00425 <i>lb Avoir.</i>	8153 7079
<i>cent per</i> <i>lb Avoir.</i>	R ⁵ 0.1019 <i>a pood</i> £ 4603 <i>a long ton</i>	9846 2910 0663 0313
<i>Troy oz. per</i> <i>short ton</i>	00034866 <i>per cent</i> Edw. Stenger	7532 1231 4377 119.5

Principles Underlying Flotation

By Joel H. Hildebrand

INTRODUCTION. *The phenomena involved in ore flotation are mostly effects of surface tension, so that an understanding of this force and how it may be modified by various factors is fundamental to a scientific study of flotation.

Wherever different phases are in contact we have surfaces where the effects of surface tension may be apparent. It will be convenient, for our purposes, to classify the boundaries between phases as follows: (1) liquid-gas, (2) liquid-liquid, (3) liquid-solid. The boundaries solid-gas and solid-solid will not be considered, being unimportant from the standpoint of our sub-

junct size. A general idea of the magnitude of this force may be obtained from the values given in Table I.

TABLE I

Liquid	Temperature, °C.	Surface Tension, Dynes per Cm.
Hydrogen	-252	2
Carbon di-sulphide	20	33.5
Alcohol	20	22
Water	20	73
Ether	20	16.5
Mercury	18	436
Gold	1070	612
Sodium sulphate	880	187

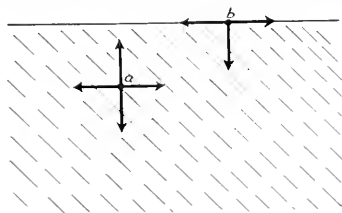


FIG. 1.

ject. Since the effects of surface tension are increased as the surface between the phases increases in extent, we will be led to consider the systems encountered in flotation processes, in which one of the phases is highly dispersed. These systems, corresponding to the above classifications are (1) foams, in which the gas is highly dispersed in the liquid (the other system, fog, in which the liquid is dispersed in the gas does not here concern us); (2) emulsions; (3) suspensions.

LIQUID-GAS BOUNDARY. (a) *Definition and Measurement of Surface Tension.* It is found that all liquids have a tendency to assume a form which will have the smallest surface. Where the liquid is supported by a surface that it does not wet it tends, for example, to assume a spherical form, manifest especially with small drops, where the influence of gravity is small. A soap-bubble tends to contract, expelling the air through the orifice of the pipe from which it is blown. A liquid that wets the walls of a tube will be drawn up into it. The magnitude of this force can be measured by various methods, such as the rise in a capillary tube, the shape of a drop under the opposing action of surface tension and gravity, the weight of a drop that surface tension will support as a liquid issues slowly from a tip of defi-

(b) *Cause of Surface Tension.* It must be noted that we can define and measure surface tension without making any assumptions whatever as to what causes it. The fact that the surface tends to contract with a definite force does not mean that the surface is coated with anything like a rubber membrane. The surface of a liquid, except for a slight difference in density, is doubtless the same as the rest of the liquid. The existence of surface tension is to be attributed to inter-molecular attraction. Consider a molecule, such as *a* in Fig. 1, in the interior of a liquid. It will be attracted by the surrounding molecules, and these attractions may be resolved axially into four equal components, as shown in the figure. Consequently nothing but viscous resistance would oppose the moving of this molecule to another portion of the liquid, provided it remains in the interior. The moment, however, it approaches sufficiently near the surface, the upward component of molecular attraction is reduced, becoming zero at the surface at *b*, if we neglect any effect of gas or vapor above the surface. The result is that we have to do work upon each molecule brought from the interior to the surface of a liquid, and any considerable extension of its surface involves the doing of a considerable amount of work against a force the component of which along the surface of the liquid we call 'surface tension.'

(c) *Effect of Temperature.* Since the increase in kinetic energy of the molecules with temperature forces them farther apart we should expect inter-molecular attraction and hence surface tension to diminish with increasing temperature, and such is indeed the case. At the critical temperature, where the density of the vapor becomes the same as that of the liquid, the surface tension becomes zero, of course.

(d) *Effect of Dissolved Substances.* The surface tension of mixtures of liquids is usually less than that which would be calculated on an additive basis, so that the more general tendency is for solutes to lower the surface tension of the solvent. We find that the surface

*Abstract of an illustrated lecture delivered before a joint meeting of the San Francisco section of the American Institute of Mining Engineers and the California section of the American Chemical Society, February 15, 1916.

tension of water is usually raised by dissolved salts, and lowered by other liquids, and especially by organic colloids, such as albumen, glue, soap, saponin, etc. Moreover, it is possible to show thermo-dynamically that solutes which lower the surface tension of the solvent tend to concentrate at the surface, still further lowering the surface tension there. For this reason very different figures are obtained for static and dynamic measurements of surface tension with solutions of such sub-



FIG. 2.

stances. Table II shows the results of such measurements with sodium oleate (soap) solutions.

TABLE II

Concentration, %	Surface Tension, Dynes per Cm.	
	Static	Dynamic
0.025	55	79
0.25	26	79
1.25	26	62
2.5	26	58

It will be seen that where time is allowed for the concentration of the soap at the surface the tension is much less than in the dynamic method, where no time is allowed for the effect to be manifest. This behavior is exceedingly important in connection with the stability of foams, emulsions, etc., as we shall see.

(e) *Stability of Foams.* Since the production of a foam (or a mist) from a liquid involves an enormous increase in surface, and consequent performance of work against surface tension, such a system is unstable unless

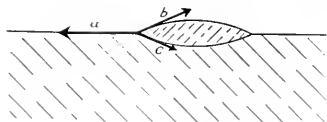


FIG. 3.

stabilized by some means. Drops or bubbles tend to coalesce, hence pure liquids never foam. To produce a stable foam requires a film that is stable. The chief condition for this is the presence of a solute that will be strongly adsorbed at the surface of the solution, lowering its surface tension, as explained above. How this will give a stable film may be understood by the aid of Fig. 2, which represents a film of solution, the shading indicating the greater concentration at the surface. If such a film should be stretched, becoming thinner at some portion, as at *a*, the new surface formed by the stretching would contain less solute, the time not being sufficient for adsorption, and hence would be stronger than the old surface. It is obvious that such a film would be stable, automatically becoming stronger whenever rupture is threatened. This is the action of the foaming agent, such as pine-oil, used in flotation processes. Here,

of course, a foam of great stability is undesirable, as it must be broken down later.

Other factors of minor importance in foam stability are viscosity, which retards the draining of the film (hence the frequent addition of glycerine to soap bubbles); small volatility, preventing evaporation of the foam where exposed to the air, and the protection of the bubbles from coalescence by the forming of a skin or armor about them. The particles of solid ore present in the foam in flotation processes undoubtedly act in this way.

LIQUID-LIQUID BOUNDARY. Much that has been said applies here. Methods of measurement are similar. The magnitudes of these interfacial tensions are illustrated in Table III.

TABLE III

Boundary	Surface Tension, Dynes per Cm.
Mercury-water	379
Benzene-water	33
Turpentine-water	12
Methyl alcohol-carbon di-sulphide.....	0.82

This surface tension becomes zero at the critical temperature of mixing of the liquids, and it is affected by dissolved substances according to the same principles as apply to the simpler systems.

(a) *The Spreading of Drops.* The spreading of drops of oil upon water to form an exceedingly thin film is familiar to all. Whether or not this phenomenon takes place depends upon the magnitudes of the three surface tensions indicated in Fig. 3, which represents a drop of a lighter liquid placed upon a heavier one with which it does not mix. Obviously the drop will spread out over the surface whenever the surface tension represented by *a* is greater than the sum of *b* and *c*. When $a < b + c$ the drop will remain in lens form upon the other liquid. One of these cases may be converted into the other by the addition of suitable solutes to one phase. For example, although oil usually spreads upon water, where the surface tension of the water is much lowered, as it is in meat-broth by the presence of albumen, gelatin, etc., the value of *a* is small enough to allow any oil present to remain as lens-shaped drops.

(b) *The Stability of Emulsions.* This is obviously favored by a low surface tension between the phases, by viscosity, by the presence of a substance tending to form a skin preventing the droplets of the enclosed phase from coalescing, as they naturally tend to do, and most important of all, the presence in the phase that is to enclose the other of a substance that will be positively adsorbed at its surface, thus making stable a film of the liquid separating two droplets of the other, enclosed, liquid. The enclosed phase takes the place of the bubbles in the previous discussion of foam stability. By a suitable choice of solutes either phase may be made the enclosed phase. For example, when soap is added to water the films of water become stable, and a liquid like benzene may be made to form a stable emulsion in water. On the other hand, when a calcium soap is dissolved in benzene films of benzene become stable, and

benzene will yield both stable foams and stable emulsions with water as an enclosed phase.

LIQUID-SOLID BOUNDARY. With a boundary of this sort direct measurement of surface tension is impossible, but relative values may be inferred by noting the wetting power of a liquid for a solid, especially as indicated by the angle of contact. When, for example, a drop of water is placed upon a bright metal surface, instead of spreading over the surface of the latter as would kerosene, it remains in drop form, its surface meeting the metallic surface at a certain angle. When a drop of castor-oil is placed upon the metal it forms a much flatter drop, the angle being different, corresponding to greater wetting power for the metal. The surface tension between these phases can be altered as before by the addition of adsorbed solutes, so that a drop of soap solution will be much flatter when placed upon the metal than the drop of pure water. This wetting power is also different for the same liquid upon different solids, as is illustrated by the experiment shown in Fig. 4, where the angles of contact indicate that when chloroform and water are in competition the former has greater wetting power for a metal surface, while the latter has greater wetting power for glass. It would seem that determinations of these angles should offer a valuable preliminary to flotation experiments.

As a consequence of this relative wetting power, if a layer of kerosene is placed over water, and a powdered siliceous material dropped into the vessel, it will stop only momentarily at the oil-water surface. As fast as the oil can be displaced by the water the particles drop through into the water phase. If, however, a metallic powder, or a sulphide with metallic lustre, be dropped into the vessel, it remains in the oil phase, supported, if the mass is not too great, by the surface tension at the boundary.

The ease with which a solid particle can float on the surface of a lighter liquid depends upon its size, the difference in density of solid and liquid, and the angle of contact the liquid makes with the solid. The relationship is expressed in Fig. 5, where we assume, for simplicity, a cylindrical particle of radius r , height h , and density d_1 , floating on a liquid of density d_2 and surface tension s . The maximum effect that could be exerted by gravity upon the particle would obviously be $\pi r^2 h g (d_1 - d_2)$ dynes. If the solid were not wet at all by the liquid and the angle of contact were zero, the upward force tending to prevent the particle from sinking into the liquid would be $2\pi r s$. In an actual case, however, where this angle is α , the upward force is $2\pi r s \cos \alpha$. It is obvious that the floating tendency would be greater the smaller the particle, the less its density relative to that of the liquid, the greater the surface tension of the liquid, and the smaller α . In floating practice the densities are not to be altered, the size of the particles is made as small as is consistent with economical grinding and subsequent recovery, the surface tension of the water cannot be increased, but is rather decreased by the agent added to produce foaming. The foaming gives a large

surface, as the total quantity of ore floated is proportional to the surface of the water and not to its volume. The most effective modification that can be made in the above factors is to decrease the angle α as

much as possible for the ore particles, while still leaving it greater than 90° for the gangue particles, the condition necessary that the latter should sink. This is the purpose of the small quantity of oil added during the grinding of the ore. The wetting power of oil for a metallic surface causes the oil, if the right kind, to spread over the metallic surface as it would over the surface of water. The water present at the same time wets the gangue preferentially, preparing for the separation that results when the large amount of water is added. It is obvious that the frothing agent necessarily added later works against the effect here desired of the least possible wetting of the ore, as it decreases the surface tension both at the liquid-air and at the liquid-solid surfaces.

A word might be said in conclusion about the stability of suspensions. Besides the stabilizing influences important in the case of foams and emulsions, another here rises to great importance, namely, the electric charges on the suspended particles due to adsorbed ions. This effect may be illustrated by dividing a suspension of fine silica into two portions, and adding to one a little acid and to the other a little alkali. It is found that in the second

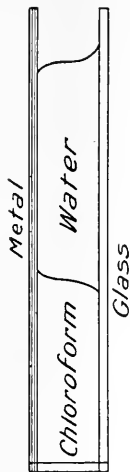


FIG 4.

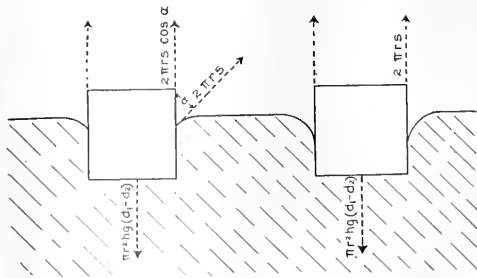


FIG 5.

case the suspension is quickly flocculated and settles out, while in the acid solution it remains suspended for a long time. Reference must be made to works upon colloids for further discussion of the many interesting phenomena connected with such behaviors. In ore flotation, the effect of even slight amounts of acid or alkali may be, aside from that just mentioned, to clean the ore particles and thus expose a more truly metallic surface to the oil, and to affect the surface tensions involved, especially by modifying chemically the other substances added, notably the frothing agent.

The Flotation of Oxidized Ores

By O. C. Ralston and Glen L. Allen

INTRODUCTION. *Concentration of natural sulphide ores by the flotation process has met with such success that attempts have recently been made to apply the process to the flotation of ores other than natural sulphides.

As inquiries on this subject are frequently received by the Bureau of Mines, it has been thought best to publish a summary of the results so far obtained from the experimental work on oxidized ores at the Salt Lake City station of the Bureau, in co-operation with the department of metallurgical research of the University of Utah. The work has been directed by O. C. Ralston, assistant metallurgist of the Bureau, and was carried on for the most part by G. L. Allen; N. C. Christensen and R. W. Johnson assisted.

As above stated, this paper is only a summary, or a preliminary report of the experiments on the flotation of oxidized ores. More complete details as regards the flotation of carbonate ores of lead will be given later, and in the near future the Bureau expects to publish a still more complete discussion on the flotation of oxidized ores of lead, copper, and zinc.

Most of the experimental work in the laboratory at the Utah station has been with the oxidized ores of lead. Only minor attention has been given to the oxidized ores of zinc and of copper for the following reasons: little success has been had with the zinc ores; many others are engaged in testing copper ores, so that there was no pressing necessity for experimentation with copper ores by the Bureau, although an attempt is being made to co-ordinate the work of those who are willing to join in solving the problem. Flotation of oxidized minerals depends upon a preliminary 'sulphidizing' by any method that will convert at least the surface of the mineral particles to a sulphide of the metal. This step is followed by flotation of the artificial sulphide, which results in a concentration of the valuable metals in the low-grade oxidized ore being treated.

The methods of sulphidizing that have been investigated are as follows: (1) By the use of hydrogen sulphide on either the dry or the wet crushed ore, (2) by the use of solutions of the various sulphides and sulpho-compounds of sodium, (3) by the use of solutions of the various sulphides and sulpho-compounds of calcium, (4) by the use of sulphur vapor, (5) by the use of a sulphuretted oil, (6) with colloidal sulphur.

It has been found that treatment by some of these methods will form a film of sulphide over the surface of the particles of such minerals as lead carbonate or copper carbonate, whereas in other cases the mineral particles are sulphidized to the core. Other methods failed

CARBONATE OF LEAD ORES. All of the above methods of sulphidizing have been tested on a great number of lead-carbonate ores. Some of these ores contained silver and some contained lead as the principal metal. A number of the ores have been successfully concentrated and others refuse to yield to concentration by flotation. In general, a high alumina content (acid soluble) in an ore seems to prevent the application of sulphidizing and flotation. The purpose of this report is to give the main features of the flotation of oxidized ores of lead, as well as other ores.

In sulphidizing with hydrogen sulphide gas, as applied to the lead-carbonate ores, it was found that the best method of applying the gas to a dry powdered ore was in a tumbling barrel with the gas inlet in the end. Sulphidizing in a glass bottle showed that the ore blackened quickly after the application of the hydrogen sulphide gas. On attempting to float out lead sulphide from the ore as soon as it had blackened it was found that a low extraction of lead was obtained and likewise a low-grade concentrate, unless the pulp was previously acidified with sulphuric acid. By acidifying the pulp, a cleaner concentrate was floated, but the extractions of lead remained low. Only by prolonged treatment with hydrogen sulphide gas could the extraction of the lead be raised to commercial grade. With a number of ores eight hours' treatment gave an extraction of over 80% of the lead.

The use of hydrogen sulphide was considered for the reason that it can be generated quite cheaply. With iron matte available at \$5 to \$10 per ton, and sulphuric acid at from \$5 to \$10 per ton, the cost of the hydrogen sulphide resulting, including labor, etc., is between \$30 and \$50 per ton. If this gas in combining with the metal in the ore produces only a superficial film of sulphide, and does not penetrate to the centre of the particles, it might be possible to make a ton of the gas sulphidize many tons of ore.

Unfortunately hydrogen sulphide attacks the metallic particles of the ore with such avidity that by the time the latter are sulphidized sufficiently to permit of good extraction by flotation, they have also been sulphidized to the core, and practically a chemical equivalent of hydrogen sulphide, to the lead in the core, has been absorbed. Even coarse pieces of ore in a bottle absorb the gas with evolution of heat, and on breaking open the pieces the black coloration is seen to have traveled deeply into the particles.

Owing to the fact that the value of the lead concentrate obtained is very low as compared to the amount of hydrogen sulphide necessary to sulphidize it, this process is not regarded as commercially practicable.

*Issued by the U. S. Bureau of Mines.

Application of hydrogen sulphide to the ground ore suspended in water does not seem to be subject to the same difficulty. True 'filming' of the particles with lead sulphide seems to take place, and the extractions possible after a short treatment with the gas are satisfactory. The speed of travel of molecules of hydrogen sulphide gas, as compared with the speed of travel of the same molecules in solution affords an explanation of the difference in the action of the gas when applied to dry pulverized ore as compared with its action when applied to pulp suspended with water.

The best results on lead-carbonate ores have been obtained when sulphides of sodium were used for the sulphidizing agent. The sodium sulphide must necessarily be introduced in solution and seems to cause true filming. The sulphides of sodium considered commercially applicable are the normal sulphide of sodium, Na_2S ; sodium poly-sulphides, Na_2S_x , and Na_2S_5 , and the sulphhydrate of sodium, NaSH . Of these, the last, the sulphhydrate, seems to be effective, as is evidenced by the quicker blackening of the pulp, and the deeper blacker color formed. The normal sulphide is almost as effective; the poly-sulphides seem to be the least active. Different ores require 10 minutes to 24 hours of contact with the solutions of sodium sulphide, depending on the properties of the ore and on the strength of the solution. Amounts of sodium sulphide varying from 10 to 20 lb. per ton of ore are usually sufficient, and should be applied to pulp containing about one ton of water per ton of ore, in order that the solution may be as strong as possible during the sulphidizing stage of the process. After a good black color has developed and the color has ceased to increase in blackness, the pulp is diluted with water to a 3:1 or 4:1 mixture and floated in either mechanically agitated or pneumatic machines. The market for sodium sulphide is limited and it should be obtainable at considerably less than 2 cents per pound.

The poly-sulphide of calcium, obtained by boiling powdered sulphur with slaked lime, seems to be satisfactory for ores that yield easily to sulphidizing, but is sluggish in its action, as compared with the sulphides of sodium. The normal sulphide of calcium is only slightly soluble and hence its use was discontinued as a possible sulphidizing agent. The sulphhydrate of calcium is the most active of these reagents, but has not been tested to any extent in this work, as there is doubt as to whether it would be commercially feasible to prepare such a compound.

Sulphidizing with sulphur vapor has been tried with little success, for the reason that it must be applied at a temperature above the boiling-point of sulphur in order to prevent condensation of the sulphur. This means that the ore must be heated to a temperature above 445°C . There seems to be no difficulty in obtaining elemental sulphur vapor commercially, as pyrite will give up half of its sulphur content when heated in a closed space, and sulphur di-oxide gas can be reduced to elemental sulphur by passing it through a heated zone in the presence of a reducing agent. As lead itself is easily reduced from its carbonate form, the temperature

might as well be raised to the point where the lead can be liquated out, a reducing atmosphere being used instead of a sulphidizing atmosphere.

The use of a sulphuretted flotation oil, in which loosely combined sulphur is available for combination with carbonates of lead or other metals, and the rest of the oil is then available for 'oiling' the artificial sulphide, has given but little encouragement in the tests conducted by the Bureau. Finally, colloidal sulphur, mentioned as a possible method of sulphidizing, does not seem to combine with lead carbonate at all. It floats as a white lining of the air bubbles in the flotation machine, and brings up very little lead with it.

Usually the precious metals contained in a lead-carbonate ore accompany the lead. We have noticed that the silver extraction will lag behind the lead extraction when the ore is sulphidized with sodium sulphide, and that the reverse has usually been true when hydrogen sulphide was used.

The importance of sulphidizing flotation is due to the fact that there are many deposits of lead carbonate ore in all of the Western States and many of these ores have been milled with varying success. Frequently the lead carbonate can be concentrated satisfactorily by gravity methods, but often it is found that the particles go into the slime and are lost. Tailing heaps containing 5 to 10% of lead are common. The object of this investigation is to determine whether sulphidizing flotation could not be applied to the treatment of the deposits of lead carbonate above mentioned, to prevent the waste that now takes place when these ores are treated by gravity-concentration processes, and render amenable to treatment carbonate ores that are too low-grade to be treated by present methods.

The General Engineering Co., of Salt Lake City, has carried on extensive tests of different lead-carbonate ores with varying success, according to the ore tested. The company owns several sulphidizing methods, which it has either patented or purchased.

A flotation plant to apply sulphidizing and flotation to an ore containing lead, silver, and gold is being constructed by the Prince Consolidated Mining Co., at Pioche, Nevada, for the treatment of two tailing-dumps from former pan-amalgamation and cyanide operations in that vicinity. This plant is expected to be in operation shortly.

OXIDIZED COPPER ORES. Many attempts have been made, both by large operating companies and by other experimenters, to float the carbonate and other oxidized minerals of copper. For that reason the testing of such ores by us has been limited.

Hydrogen sulphide seems to be by far the best medium for sulphidizing oxidized copper ores previous to flotation. When applied to the dry ores we found the same conditions as those mentioned for lead; the particles are sulphidized to the centre, which requires an excessive amount of hydrogen sulphide. Applied to the wet pulp, the hydrogen sulphide seems to cause true filming. Our work has yielded a black concentrate, but we are informed by Mr. J. M. Callow, of the General Engineering

Co., that the company has been able to reduce the amount of sulphur used to a point where the froth is green with slightly coated malachite. He states that as little as half a pound of sulphur per ton of ore is giving good extractions in the plant of the Magma Copper Co., at Magma, Arizona, where his company has put in the first successful installation of this kind.

Sodium sulphide has been tested by a number of the larger companies that have oxidized copper minerals in their sulphide ores. The amount of oxidized copper in such ores is usually a fraction of 1%, so that only two or three pounds of sodium sulphide per ton of ore is necessary. This is usually added to the machines during flotation, or to the mixing-tanks before flotation. Our experience is that if some little time of preliminary contact is allowed before flotation is attempted, better sulphidizing of the material will result.

Calcium poly-sulphide has been used for some time in

a number of the large copper concentrating mills with indifferent success, and seems to be detrimental in some instances. On the ores tested by us fair results were obtained if the calcium poly sulphide was allowed to act until the ore had become well blackened.

It is stated that sulphur vapor was tested at one of the large plants for flotation of oxidized forms of copper and gave better results than any other method of sulphidizing. Of course this method has the disadvantage of having to be applied to dried, heated, and finely divided ore.

Sulphuretted oils are being used at a number of plants to supplement other methods of sulphidizing and considerable secrecy is observed as to the technical details of this work.

So far as we know, colloidal sulphur does not assist in the flotation of oxidized forms of copper. Neither has the silicate of copper been successfully floated by

METHOD OF SULPHIDIZING

- No. 1. Two hours' treatment with H_2S gas on dry ore.
- No. 2. Four hours' treatment with H_2S gas on dry ore.
- No. 3. Eighteen hours' treatment with 1% solution of Na_2S , 20 lb. per ton of ore.
- No. 4. Three hours' treatment with 0.8% solution of CaS_2 , 16 lb. per ton of ore.
- No. 5. Four hours' treatment with 1% solution of

- Na_2S , 20 lb. per ton of ore.
- No. 6. One-half hour's treatment with 6% solution of Na_2S , 12 lb. per ton of ore.
- No. 7. One-half hour's treatment with 0.75% solution of Na_2S , 15 lb. per ton of ore.
- No. 8. Short-time treatment with hot 1% solution of Na_2S , 20 lb. per ton of ore.
- No. 9. Na_2S or H_2S in various amounts.

RESULTS OF SULPHIDIZING AND FLOTATION OF OXIDIZED ORES

LEAD-SILVER ORE.

No.	Mine	Metal Content of Ore		Metal Content of concentrate		Extraction	
		Lead, %	Silver, Oz.	Lead, %	Silver, Oz.	Lead, %	Silver, %
1	Daly Judge, Utah	16.1	29.6	33.6	11.5	83	80
2	May Day, Utah	4.2	2.36	24.6	9.6	80	55
3	May Day, Utah	4.5	2.8	28.4	12.04	86	64
4	May Day, Utah	4.5	2.8	26.1	11.5	73	48

LEAD ORE.

		Metal Content of Ore		Metal Content of Concentrate		Extraction	
		Lead, %		Lead, %		Lead, %	
5	Wilbert dump, Idaho	5.77		28.2		54	
6	Seranton, Utah	8.74		65.0		88	

LEAD-SILVER-GOLD ORE

		Metal Content of Ore			Metal Content of Concentrate			Extraction		
		Lead, %	Silver, Oz.	Gold, Oz.	Lead, %	Silver, Oz.	Gold, Oz.	Lead, %	Silver, %	Gold, %
7	Shattuck, Arizona	15.42	12.88	0.05	18.3	4.7	0.128	88	80	70

COPPER-SILVER-GOLD ORE.

		Metal Content of Ore			Metal Content of Concentrate			Extraction		
		Copper, %	Silver, Oz.	Gold, Oz.	Copper, %	Silver, Oz.	Gold, Oz.	Copper, %	Silver, %	Gold, %
8	Grand Central, Utah	0.60	4.80	0.22	1.75	7.0	0.8	67	77	7

ZINC ORE

		Metal Content of Ore		Metal Content of Concentrate		Extraction	
		Zinc, %		Zinc, %		Zinc, %	
9	Honorine, Utah	28.15		77.7		80	

sulphidizing flotation. It will blacken when sulphidized, but resists flotation. Possibly it still presents a silicate, rather than a sulphide, surface to the flotation elements. For this reason a number of the large copper companies are seriously contemplating leaching the oxidized copper ores, rather than lose what silicate of copper may be present.

Repeated attempts to float the natural sulphides along with sulphidized minerals have failed, as the sulphidizing agents cause trouble with the flotation of the natural sulphides. By careful adjustment this difficulty has been solved in one plant, though the details are not available.

OXIDIZED ZINC MINERALS. Attempts to float the particles of oxidized zinc, both before and after sulphidizing by most of the above methods, have met with no success whatever in our laboratory experiments. We are informed that some headway was made with the problem by Prof. F. W. Traphagen, at the Colorado School of Mines, but that the sulphide film seemed to come off too easily. However, poor results were obtained, whatever the cause.

Our experience has been that most of the carbonate ores of zinc contain important amounts of the silicate, and this may be one reason for the non-success of this work, for the same reasons that copper silicate will not float.

Direct flotation of oxidized minerals of the kind mentioned, so far as known, has not been successfully accomplished. In all of the successful work witnessed by us there has been some form of alteration of the oxide to the sulphide. A number of parties claim to be successful in the flotation of copper carbonates without sulphidizing, and others in the flotation of scheelite, fluorite, and magnetite. We were unable to verify these statements.

RESULTS OF TESTS. Some of the best results and some average results which have been obtained in the work at the Utah station, are given in the table on the preceding page.

PATENTS. A list of patents dealing with methods of sulphidizing and flotation follows:

U. S. Patent	807,591	Dec.	19, 1905	A. Schwarz
U. S. Patent	1,091,760	April	28, 1914	J. T. Terry
U. S. Patent	1,098,668	June	2, 1914	H. B. Hovland and G. B. Frankforter
U. S. Patent	1,140,865	May	25, 1915	R. F. Bacon
U. S. Patent	1,140,866	May	25, 1915	R. F. Bacon
U. S. Patent	1,159,912	Nov.	9, 1915	H. B. Hovland
U. S. Patent	1,180,816	April	25, 1916	R. F. Bacon
British Patent	26,019	Nov.	10, 1909	H. L. Sulman and H. P. K. Picard

Provisional specifications 28,612, Sulman and Picard, applied for Dec. 7, 1909, and 29,616, applied for Dec. 17, 1909, are incorporated in British Patent 26,019.

THE FOREIGN TRADE of the United States during the fiscal year ended June 30 reached the enormous total of \$6,189,148,585, which exceeds by more than \$2,000,000,000 the trade of any previous year, and compares with a total \$2,241,424,266 in 1900. The excess of ex-

ports over imports during the last fiscal year was \$2,145,082,161, comparing with the ordinary figure before the War of about \$500,000,000 per annum. Of our total foreign trade about 55% is with Europe; of the exports alone, about 65% goes to Europe. Comparing American foreign trade with that of Japan, our exports and imports during one month, May 1916, were more than the whole foreign trade of Japan for a year. Japan's foreign trade is about \$600,000,000 per annum, being less than that of Canada, which, with one-sixth the population of Japan, has a foreign trade of more than \$1,000,000,000. Australia, with 5,000,000 people, has a foreign trade equal to that of Japan. In the same class are China, Switzerland, and Brazil. Great Britain's foreign trade amounts to over \$6,000,000,000 per annum, Germany's foreign trade was about \$5,000,000,000 before the War, that of France is \$3,000,000,000 and the Netherlands \$2,500,000,000.

Platinum Production

Production of crude platinum in California and Oregon in 1915, according to the U. S. Geological Survey, was 741.91 troy ounces, having a value of about \$23,538, an increase of 171.91 oz. over the production in 1914. Californian mines produced most of this quantity; only one mine in Oregon reported production in 1915. The Rambler mine, Albany county, Wyoming, produced platinum-bearing copper concentrate, which was shipped to Eastern refiners. No platinum ore was shipped from the Boss mine, Clark county, Nevada.

According to reports received by the Survey from the platinum refiners, 8665 oz. of new metals of the platinum group was recovered, of which at least 1587 oz. is believed to be of domestic origin. Secondary metals derived from the refining of scrap and sweeps to the amount of 42,970 oz. were sold in 1915.

Notwithstanding the embargo placed on the exportation of platinum by all the Allied governments, United States imports of platinum and allied metals during the year 1915, as compiled by the Bureau of Foreign and Domestic Commerce, Department of Commerce, were only 10% below the 1914 imports, amounting in all to over 69,000 oz., having a value of \$2,768,688.

Figures showing the world's production of platinum and allied metals are at best estimates made from the most reliable information obtainable, and the table below gives the best estimates from information available to the Survey at this time (the figures are in ounces):

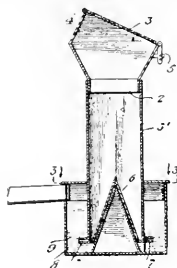
Country	1912	1913	1914	1915
Borneo and Sumatra.....	200	200	(*)	(*)
Canada	30	50	30	100
Colombia	12,000	15,000	17,500	19,000
New South Wales	778	1,275	1,248	756
Russia	300,000	250,000	241,200	124,000
United States.....	721	483	570	742
	313,729	267,008	260,548	143,898

*No basis for estimate.

†No figures from Tasmania available at time report goes to press.

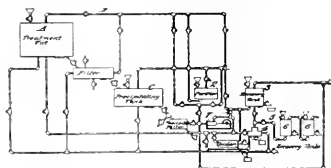
Recent Patents

1,178,001. GOLD-SAVING DEVICE. George Edick and John E. Davern, Albuquerque, N. Mex. Filed Sept. 24, 1915.



A device for separating float or flour gold from fine foreign substances, comprising a mercury receptacle, a vertical column extending downwardly into said receptacle and provided with a plurality of sides, a pyramidal deflector extending upwardly into the lower end of the mercury column, said deflector having a series of sloping sides equal in number to the sides of the column and sloping toward the lower ends thereof, the deflector being provided with horizontal flanges defining narrow elongated horizontal exits into the body of mercury, and an inlet at the top of the column.

1,178,081. PROCESS OF CYANIDING. Harai R. Layng, San Francisco, Cal. Filed Mar. 19, 1913.



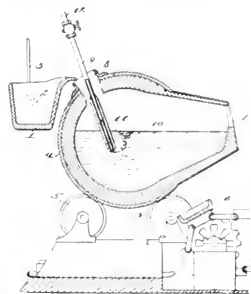
1. A method of extracting values from ores and recovering cyanid from its solution which consists in first treating the ores with a cyanid solution, then filtering the solution to remove the undissolved residue, conveying the pregnant solution to a sealed receptacle, adding a chemical to liberate cyanid and to precipitate salts of the metals, conveying the liberated cyanid to a recovery device to recover the cyanid, and filtering the remaining solution to recover the precipitated salts.

1,182,951. PROCESS OF DESULFURIZING ORES. Howard F. Wierum, Upper Montclair, N. J., assignor to the Sulphur Syndicate Limited, London, England, a Corporation. Filed Dec. 29, 1914.

1. A process of separating sulfur from metallic sulfids, which consists in first subjecting the ore to a temperature sufficient to distil a larger part of the less stable atom of sulfur present in the raw ore, and in an atmosphere which is non-oxidizing; then passing the ore through another section of the same furnace, in which a highly reducing atmosphere is maintained, and a temperature preferably just under the fusing or melting temperature of the material under treatment; then passing the material through a third section of the furnace, in which an oxidizing atmosphere is maintained, in which third section a greater or less amount of the sulfur remaining in the material under treatment is oxidized and sulfur dioxide, usu-

ally with some trioxid, present, and passing the gases and vapors formed throughout these successive steps in a direction opposite to that of the travel of the ore, thus providing means for the reduction of sulfur oxids formed in the third section of the furnace to be reduced to sulfur in their passage through the second section of the furnace, and also means for preventing either the oxidation or combination with carbonaceous matter of the elemental sulfur distilled in the first section of the furnace, as well as the elemental sulfur produced in the second section of the furnace.

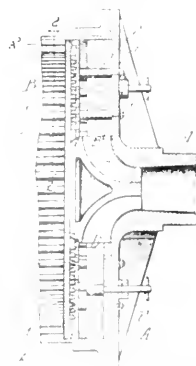
1,183,736. PROCESS OF REFINING COPPER. Edward C. King, Cananea, Mexico. Filed October 22, 1910.



1. The hereindescribed improvement in the art of refining copper in an oxidized condition, which consists in introducing hydrocarbon oil free from oxygen into direct contact with the interior of a body or bath of molten copper while the latter is protected from oxidizing influences.

2. The hereindescribed method of refining copper which consists in introducing liquid hydrocarbon oil free from oxygen into the interior and below the surface of a body of the metal while in a molten state and while in an oxidized condition, and continuing such operation until all the impurities and the oxygen contained in the copper have been eliminated therefrom.

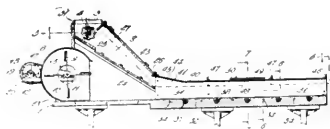
1,183,431. TUBE-MILL. David E. Carlson, Chicago Heights, Ill., assignor to Chalmers & Williams, Inc., Chicago Heights, Ill., a Corporation of Illinois. Filed July 11, 1915.



1. A diaphragm plate for a tube-mill comprising separate plates secured together and adjustable relatively to each other,

said plates being provided with holes the edges of which overlap, the holes of one of said plates being relatively large, and projections on the other plate which extend into said holes, said projections being narrower than the width of said holes and forming sides of free openings in the plate other than that on which they are formed, the opposite sides of said free openings being formed by the edges of the holes in said plate which overlap the edges of the holes in the plate on which said projections are formed, substantially as described.

1,183,226. DRY ORE-SEPARATOR. David M. Owings, Canton, and William R. Kinsey, Bartlesville, Okla. Filed Dec. 16, 1915.

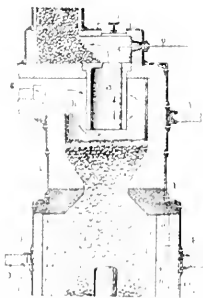


1. In a dry ore separator the combination of a concentrating table having spaced metal receiving channels therein, a hood inclosing said table and open at its opposite ends, means for discharging a blast of air through said hood over said table, means for feeding ore containing material to said hood in the path of said blast, and cylindrical agitators having radially projecting teeth and disposed entirely within said channels to avoid obstructing the surface of the table over which the ore containing air blast is directed.

1,182,890. SEPARATION OF METALLIC SULFIDS. Leslie Bradford, Broken Hill, New South Wales, Australia. Filed Sept. 10, 1913.

1. A process for the preferential or selective separation of zinc sulfids from lead sulfids in ores containing mixed sulfids which consists in submitting the ores to agitation with a frothing agent in a heated feebly acidulated solution of common salt of such a nature as to render the lead sulfid particles immune to flotation while in the said medium but as not to affect the subsequent floatable properties of the said lead sulfid particles by the ordinary flotation treatments and which does not similarly affect the zinc sulfid particles and permits the said zinc sulfid particles to float substantially in the manner hereinbefore described.

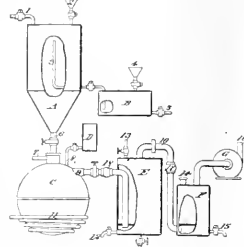
1,184,520. ELECTRIC FURNACE PERMITTING THE EXTRACTION IN A STATE OF PURITY OF ZINC FROM ITS ORES. Eugène Francois Côte and Paul Rambert Pierron, Lyon, France, assignors to Société Anonyme pour l'Electrometallurgie du zinc, Procédés Côte, et Pierron, Lyon, France. Filed July 24, 1914.



1. An apparatus for extracting zinc from ores in a state of purity, comprising a furnace for melting the ores, and a refining furnace into which the zinc vapors from the melting furnace are delivered, said refining furnace being provided

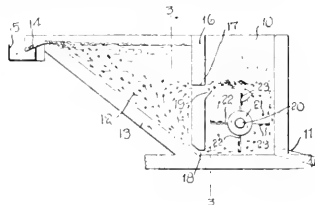
with means for condensing the zinc vapors in the form of drops or powder, and with means for re-distilling the zinc drops or powder, whereby the metal will be refined successively with the production thereof while at a temperature next to the point of volatilization thereof.

1,183,986. PROCESS OF CYANIDING. Harai R. Layng, Seneca, Cal. Filed Dec. 29, 1914.



1. A process for regenerating cyanid and recovering values from a cyanid solution containing compounds of valuable metals which comprises treating the solution with suitable chemicals of precipitate cyanogen compounds of the metals, separating the precipitate so formed from the solution, and treating the precipitate with a mixture comprising an oxidizing agent and capable of converting cyanid into hydrocyanid acid, substantially as described.

1,187,822. ORE-CONCENTRATOR. George B. Eberenz and James I. Brown, Cripple Creek, Colo. Filed Mar. 2, 1916.



1. An apparatus for concentrating ores by gaseous flotation of mineral particles in liquid, including an agitating tank and a spitzkasten, the agitating tank having an opening at its base leading into the base of the spitzkasten and an opening leading from the spitzkasten and into the agitating chamber above the base and below the overflow level of the spitzkasten, and an agitator rotating in a vertical plane within the agitating tank and disposed below the plane of the second-named opening, the agitator rotating in such a direction as to draw liquid inward into the agitating tank from the spitzkasten by the upper opening but force liquid from the agitating tank into the spitzkasten by the lower opening, the upper and lower openings being so proportioned as to maintain a liquid level in the agitating tank lower than that in the spitzkasten.

1,185,757. PROCESS OF PREPARING PURE ZINC-SULFATE SOLUTION FROM ZINC ORES. Shunjiro Araki, Osaka, Japan. Filed Sept. 6, 1913.

1. The process of producing a pure zinc sulfate solution from zinc ores which comprises extracting the ores with a sodium bisulfate solution, removing from the solution the heavier metals by treatment with metallic zinc, separating the greater part of the iron and manganese by neutralizing with alkali and by treatment with an oxidizing agent, and removing the remainder of the iron and manganese by adding sodium silicate, neutralizing the sodium silicate with sulfuric acid to form silicic acid and sodium sulfate, and heating the resulting solution containing silicic acid to convert the dissolved colloidal silicic acid into an insoluble form.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

PRODUCTION FOR HALF YEAR.—NEW MINES.—LOCAL BUSINESS.—
IOWA GULCH MINES.—DREDGING.

The first six months of the current year shows the Leadville district to have made a record both in ore production, value of output, and in increasing the development of old and new properties. Production in January was approximately 60,000 tons, an average of nearly 2000 tons daily; February dropped to 57,000 tons, but with a daily average equal to that of the previous month; March recorded a small gain with 63,000 tons; April continued the advance with 66,000 tons; May following with 73,000 tons; and June produced 83,250 tons, an increase of 10,000 tons over any previous month. The total output of the district during the half-year is 402,250 tons. Most of the ore has been zinc carbonate and zinc-lead sulphides, both of which have realized high prices during the period. The other ores vary from low-grade iron-manganese to high-grade gold-silver, including several shipments of bullion from the Derry dredge. The estimated value of production is \$10,000,000.

During the term 1 new and 28 old mines resumed operations. Among these, the most important are the Harvard and Tip Top on Fryer hill controlled by the U. S. S. R. & E. Co.; the Mikado on Iron hill, under the management of George O. Argall; the Greenback in Graham Park, owned by Patrick Mulrooney and rated as one of the best mines in the district; and the McCormick on Yankee hill, purchased from the Small Hopes-Boreel Mining Co. by the Empire Zinc Co. The others are smaller properties in all parts of the district, indicating a most unusual revival. The activity reaches from Iowa gulch on the south, through the district into Prospect mountain and East Tennessee gulch on the north, and includes a number of properties on Sugar Loaf to the west, an area that has had little development for years.

A general wave of prosperity due to the mining uplift is also noticeable in business circles. Real-estate men say that the value of property in Leadville has increased at least 10% during the past six months. Good store lots are held at a premium, and there are but few inhabitable residences unoccupied. Property owners have been busy during the spring and summer months repairing old houses, putting them into shape for tenants who are daily coming in from other places. Fully 200 men have been added to the district pay-rolls since the first of the year, and several times that number will find employment as soon as the Down Town and Fryer hill mines begin mining in earnest. The Mikado enterprise will not be ready for development this year but will be a factor in 1917.

The work recently started in Iowa gulch is at present attracting no little interest from local mining men. Steady shipments are being made from the Lilian, one of the oldest properties, and it is stated that the output from the mine is now far greater than it has been for years. Several groups of lessees are developing the property, most of the work being done in the upper levels where many large bodies of carbonate of zinc have been found. Some good gold-bearing ore is also being shipped from the Lilian, and present indications are promising.—The First National, also one of the early day mines of Iowa gulch, is producing a regular tonnage of lead-zinc ore containing good value in gold and silver. This makes it the best policy of the operators to ship the material as a

lead-silver ore rather than a lead-zinc combination, although a good price could be secured for the latter.—The Continental Chief, one of the well-known mines of the district is being developed again after several years of idleness, it is reported that some good ore has been uncovered.—The Brian Boru is shipping a steady output of carbonate of zinc from a large vein outcropping at the surface.—Lessees are preparing to resume operations on the Doris where some good carbonate was found last fall.—Owners of the Gipsy Carbonate are about ready to start development again.—It is stated that Denver people are inspecting the Ilex and surrounding ground, proposing to undertake a large drainage enterprise similar to those just completed in other parts of Leadville.

The Derry Ranch Gold Dredging Co.'s boat, operating in Box creek, is having a remarkable success. Weekly clean-ups are being made, and although the exact value of the gold has not been made public, the manager states that it is profitable. This year's results are reported to be better than those of last year. Leadville people traveled over this deposit for years without suspecting its value.

Denver people are preparing to do some extensive diamond-drilling in Prospect mountain, close to the Valley adit, where ore has recently been opened. The entire area on the mountain from the Valley and Omega group, north to the Anderson adit ground near Birdseye on the northern slope, and west to the Mansfield group, covering several square miles, has been staked out by pioneer Leadville mining men who have made their fortunes here and are now residing in Denver. This entire territory will be patented and extensive development done in the near future.

JOPLIN, MISSOURI

THE MISSOURI-KANSAS-OKLAHOMA REGION FOR THE FIRST HALF OF 1915.—MIAMI, OKLAHOMA, DEVELOPMENT.

The first half of 1916 showed total shipments of zinc and lead concentrates aggregating over \$20,000,000 in value, a record over all previous periods. The value in detail was as follows: blende, \$17,085,500; calamine, \$1,919,605; and lead, \$2,503,380. This represents an increase of \$6,955,829 for blende, \$549,641 for calamine, and \$1,405,289 for lead products. These remarkable increases were in part due to increased prices, but also to larger output for the same period. The average price for the first half of 1916 for blende was \$97.38; for calamine, \$70.33, and for lead \$89.58 per ton of 60%, 70%, and 80% products. This compares with \$79.62, \$42.63, and \$51.38 respectively in the same period of 1915. This alone accounts for a large portion of the increase. The increase in price for zinc concentrate is slightly in excess of \$25 per ton, while the increase in the price of lead ore is nearly \$10. Turning to the increase in tonnage, the first half of 1916 produced 175,149 tons of blende, 14,652 tons of calamine, and 27,943 tons of lead. These were gains of 32,000 tons in blende, 3415 in calamine, and 6569 in lead. This does not tell the whole story, as there was stored in bins of ore producers as surplus stocks on June 30, 23,650 tons of zinc ore, compared with 1150 in 1915; and 2000 of lead ore, against 825 tons in 1915. Stocks and increased shipments combined gave a total increase of 35% for zinc and 334% increase in lead. This represents 1810% more than anticipations of the operators at the beginning of the year.

The increase has been a steady growth since the first of

January, and represents the completion of many of the prospecting enterprises undertaken during the latter part of 1915. It also represents in a large measure the revival of many of the low-grade sheet-ground ore mines that had been developed and abandoned during the former period of high prices and reaction in 1907 and 1908. There is yet to come that increase in production which will result from the unusually large number of new producers in the Miami, Oklahoma, district. This field will add a large tonnage to the production during the second half of 1916, and should prices for ores be reduced to a level that would result in the curtailment of production in the sheet-ground district of Webb City, Prosperity, and Duenweg, the increase from Oklahoma alone will probably make up for that decrease by the end of the year. The new mines brought-in from the Oklahoma district belong to that class of producers that can mine profitably when the price is \$10 to \$50 per ton, an advantage not possessed by sheet-ground men.

Development in the Oklahoma field is in many ways one of the most remarkable features in the Joplin district. Starting as an isolated and a small group of prospects developed under adverse conditions, the area has grown fast until it is now one of the richest zinc and lead centres. When first opened, the mines produced concentrate low in zinc and high in iron, bitumen, and silica. These impurities brought the prices paid for the product to a low figure, in some cases as low as \$5 per ton for the finished product; a condition that would have prevented any further development had it continued. With development at deeper levels, however, the amount of iron pyrite decreased, there was no bitumen worth mentioning, and the grade of the concentrate improved equal to that of any other part of the field. With this the advantages of this

centre at once appealed to all mine operators, and the influx of capital, new prospectors, and features of greater importance than in any other mining territory of the centre. No single part of the field ever had the number of prospect drills at work that this one had. Prospecting has been not only extensive, but thorough, and an ore deposit was thoroughly developed before the mill was built, a feature of the work that is entirely different from the former procedure in the older parts of the district. The character of the drilling is different also from that that has formerly been done. Instead of being generally distributed over a lease, the prospector so places the drill-holes that they cross-section the ore-deposit. This has been brought about largely by local experience, of which has shown the deposits to consist of long "runs," the linear dimensions ranging from $\frac{1}{2}$ to $\frac{3}{4}$ of a mile or even greater, while the width of the run would be from 20 to 200 ft. It soon became evident to the prospector that if he put a series of holes across part of such a run that a general distribution of the holes along it would prove of little value. A single cross-section at another point would not only be of

as much value as the general distribution of the holes, but more so in that it gave a chance to determine the width and direction, as well as the thickness of the deposit at a much lower cost. This system of drilling is now generally adopted.

During 1915 there were around 40 drill-rigs constantly at work in the Miami district; during 1916 so far, there have been 150. Naturally such development has shown the existence of a large amount of mineralized ground, and has added a large tonnage to the known reserves at Miami. Following in the wake of the drill-rigs has come the sinking of shafts and the building of mills, so that today the actual tonnage of ore extracted has been largely increased, and the potential production for the remainder of the year will undoubtedly show a much larger increase.

Zinc ore dropped \$5 per ton again last week. Lower prices and a shortage of electric current, due to an accident to the Empire District's Riverton plant, combined to cause a number of large producing mines to shut-down during the week. Most of the sheet-ground producers of West Joplin are down, and several in North Webb City. It is estimated that the production is curtailed at least 1000 tons. There is also less water in the Spring river since the recent rains stopped. It is estimated that concentrate stored totals 7500 tons. In the Oklahoma section the largest surplus is said to be in bins. The output of the Missouri-Kansas-Oklahoma region was 5118 tons of blende, 44 tons of calamine, and 941 tons of lead, averaging \$65, \$45, and \$75 per ton, respectively. The total value was \$405,600.

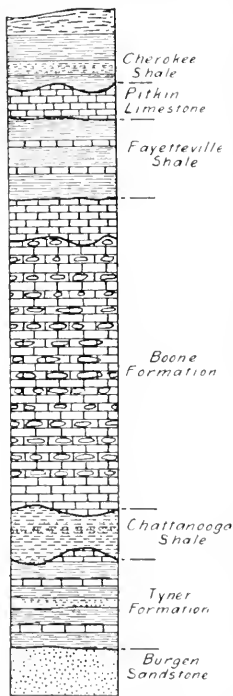
SUTTER CREEK, CALIFORNIA

ONEIDA AND SOUTH EUREKA.—EUREKA PROGRESS.—CENTRAL EUREKA.

Twenty stamps are dropping at the Oneida mill, one of the plants operated by the South Eureka company, which has 80 stamps crushing on its own mine. An underground hoist is now being installed on the 2200-ft. level of the Oneida shaft for the purpose of sinking a winze and developing that mine deeper than heretofore. The new hoist has a sinking capacity of 1500 ft. The shaft has been unwatered within 400 ft. of the sump, and the block of ground to be opened by this winze and the unwatering of the shaft should yield ample ore to keep the two mills well supplied for some years. The South Eureka company purchased the idle Oneida mine several years ago, the object being to connect the shaft with that of the South Eureka mine, forming a safety exit and improving ventilation. Connections were made, and some ore of good grade opened in making connections, but until recently little work has been done at the Oneida. It was in unwatering the mine below the connecting cross-cut that a shoot of good ore was found that warranted starting 10 stamps of the mill. Now there is no difficulty in keeping 20 stamps supplied. Henry Schmal is superintendent of the combined properties, under general manager H. Malloch. About 250 men are employed.

The old Eureka shaft has been unwatered to a depth of 380 ft. from the surface. Three sinking-pumps are working, and as soon as the shaft is cleared to 600 ft. it is intended to install another pump. Far better progress is being made than was anticipated in re-opening the old shaft, as many of the timbers do not have to be changed. Three shifts of shaft men are employed, and a number of men are engaged on the surface plant.

The sump below the 3200-ft. level of the Central Eureka shaft is being cleaned out, and sinking will be started at once for the purpose of opening at greater depth the good ore mined on the present lowest level. Twenty stamps of the mill are crushing ore from the 2800, 3100, and 3200-ft. levels, and sufficient ore is now available to permit starting another 10 stamps within a few days. W. J. Bryant has been appointed foreman of the mine, taking the place of W. Parrow, who resigned.



GEOLOGICAL SECTION OF NORTH EASTERN OKLAHOMA.

building of new mills became more than in any other mining territory of the centre. No single part of the field ever had the number of prospect drills at work that this one had. Prospecting has been not only extensive, but thorough, and an ore deposit was thoroughly developed before the mill was built, a feature of the work that is entirely different from the former procedure in the older parts of the district. The character of the drilling is different also from that that has formerly been done. Instead of being generally distributed over a lease, the prospector so places the drill-holes that they cross-section the ore-deposit. This has been brought about largely by local experience, of which has shown the deposits to consist of long "runs," the linear dimensions ranging from $\frac{1}{2}$ to $\frac{3}{4}$ of a mile or even greater, while the width of the run would be from 20 to 200 ft. It soon became evident to the prospector that if he put a series of holes across part of such a run that a general distribution of the holes along it would prove of little value. A single cross-section at another point would not only be of

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JUNEAU

Progress at the Alaska Juneau property is as follows: Steel frame for the coarse-crushing plant is completed, and the sides and roof are being put on. Power-house frame is half finished. Sixty per cent of the mill-building foundations are made. Some machinery for the crushing and power plants has arrived. The crushers will be two No. 9 gyratory and two 36 by 48-in. jaw type. Two generators are to be 6000 kw. each.

According to B. L. Thane of the Alaska Gastineau, on June 26 the mill treated 5700 tons of ore. Since the beginning of the operation of the big mill, the average cost of mining and milling the ore has been considerably under the 75c. per ton, which was the original estimate made by the engineers. Eminent men of the mining profession freely predicted that the costs could not be reduced to 75c. as estimated. For the past few months the costs have been 65c. and under. The mill is at present being operated at a 6000-ton average daily capacity, which was the original estimate, but its actual capacity is more than double that amount, or between 12,000 and 15,000 tons daily. As the mine development to the east progresses the mill will gradually be speeded up. Owing to the contour of the ground and the lay of the orebody on the west end, the ore must be taken from certain places first in order that the mine's producing capacity be not impaired. This work is now progressing rapidly and large bodies of ore of a higher value are being opened out for stoping purposes, and within a short time the mill will be at capacity as the company is able to take the ore from the east end and mix it with the west end ore, bringing the average of the ore to the correct grade.

ARIZONA

GILA COUNTY

The Inspiration Needles company at Miami has two drills in operation and will shortly start three more. No. 1 was down 125 ft. on July 17 and is making from 20 to 30 ft. daily. Over 30 men are employed.

MOHAVE COUNTY

A Marcy ball-mill has arrived at the United Eastern mine at Oatman. The new 200-ton plant includes this, tube-mills, Dorr classifiers, thickeners, etc., and Merrill precipitating presses.

The Arizona Corporation Commission has ordered the Tom Reed company to resume supplying citizens of Oatman with water. The company also sells electric current in the town. To further help the water supply the Oatman Water & Sewer Co. has been formed, and has purchased the water of the Big Jim mine, the Mazona supply and plant, and the supply and plant of the Lexington-Arizona Mining Co., which furnishes the town of Old Trails. The pipe-line of the Orion Mining Co. has been purchased. In turn, the new company will furnish water to the Orion and it will start its stamp-mill and do custom work. The Oatman water company will also pump water from wells along the Colorado river, a distance of 11 miles, as has been previously mentioned in these pages.

Owing to a wage dispute miners and mill-men at the Gold Road are on strike, affecting about 70 men. Recognition of the Snowball Miners' Union No. 124 is part of the grievance. The strike lasted 5 days, demands being granted temporarily.

For violation of the 8-hour law, allowing men to work over-

time, the manager and superintendent, two contractors, and the Pioneer company are being tried at Oatman, at the instance of the Snowball Miners' Union.

YAVAPAI COUNTY

According to J. Nelson Nevius in the *Bulletin* of the Chamber of Mines and Oil of Los Angeles, the Octave gold mine, 10 miles east of Congress Junction, in the Walker district, will shortly be a producer again. Past yields to a depth of 2000 ft. have been \$2,000,000. After erecting an expensive electric power-plant at Wickenburg, a 12-mile transmission-line, and a complete motor equipment at the mine, the property was shut-down some years ago. The vein has recently been opened beyond the fault for 270 ft., averaging 27 in. wide and \$10.00 per ton. The shoot is poor for 25 ft., followed by 90 ft. of \$12.44 ore across 4 ft. H. C. Gibbs of Boston is president of the company.

ARKANSAS

SEBASTIAN COUNTY

On July 15 the Fort Smith Spelter Co. at Fort Smith produced its first metal. Two blocks of retorts are reducing ore, others to follow at an early date.

CALIFORNIA

AMADOR COUNTY

The 40-ft. high and 500-ft. long tailing-dam of the Argonaut company has been completed at a cost of \$25,000.—The Kennedy company is to increase the height of its concrete dam by 20 feet.

INYO COUNTY

According to L. D. Gordon, general manager of the Cerro Gordo Mines Co., near Keeler, the largest body of zinc ore ever opened in the property was encountered last month on the 200-ft. level, 500 ft. south-east of the shaft. It is zinc carbonate that occurs as a replacement in limestone. It is circular in form, standing vertically, and is 25 ft. diam. A square-set slope is being carried up above the 200-ft. level, and there is a winze down 40 ft. below the 200-ft. level all in ore. It contains 35% zinc. Monthly shipments are 700 tons of ore and 1500 tons of old slag.

NIADADA COUNTY

(Special Correspondence.) A 5-ft. vein of copper-gold ore has been discovered at a depth of 35 ft. on the Downey ranch, 12 miles below Grass Valley. The ore is said to assay 5% copper and \$7.50 gold per ton. Development is proceeding under the management of W. R. Biddle.

Shipments of high-grade chrome ore are being made from the Red Ledge mine in the Washington district. The chrome is found in small decuss in a gold-bearing formation. Development of the 6-ft. vein of gold ore recently opened is proceeding vigorously, and a good quantity is going to the mill. Streaks of specimen ore are found with the milling quartz. The Red Ledge is owned by Col. & William on of Washington Grass Valley, July 16.

PLUMAS COUNTY

The Utah Construction Co. of Salt Lake City has been awarded the contract to build 27 miles of railway from the Engels copper mine in Lights canyon to Keddle on the Western Pacific at a cost of \$800,000.

At the Walker copper mine the adit has been driven into the lode for 20 ft., and is now almost under the shaft. The aerial tram is now delivering ore to the bins of the new mill, which will be finished in three weeks.

SHASTA COUNTY

Miners of the Mammoth Copper Co. are demanding an increase of 50c. per day in wages. Present wage is \$3.50 to \$3.75, plus 25c. when copper is above 26c. per lb. The bonus was not paid in June, owing to low copper. The men want straight pay and no bonus. The company has since agreed to the men's demands while copper is over 15 cents.

SIERRA COUNTY

Around Sierra City there is reported to be considerable work going on. On the west slope of Sierra Butte (8600 ft. high) is the Monarch mine supplying ore for 20 stamps.—Development in the Cleveland is expected to give good results; 25 men are employed.—An Oakland syndicate has secured a bond on the Bullion claims from F. J. Cook and others.—The Bigelow is under bond to W. B. Pearson of the Plumbago mine, near Alleghany.—Under the management of F. E. Barnett the Butte Saddle and Sacred Mound mines are being opened.—Good ore has been opened in the Chipps mine, which has 10 stamps.—The William Tell and Sierra Butte properties are practically idle.

COLORADO

CLEAR CREEK COUNTY

(Special Correspondence.)—The Colorado Central Leasing Co., operating the Colorado Central-Alhunde group of mines on Leavenworth mountain above Georgetown, will shortly start work in the construction of a 100-ton concentrating plant. It is proposed to treat all dumps of the mine, as well as extract numerous old stops. A steam tramway 3 miles long is to be constructed. T. Kyner is manager.—The Linn mill, which has been closed for the last two weeks undergoing repairs, will resume next week. A 48% lead concentrate is being made.—Work has been resumed on the Rendahl property on Bard creek and early shipments are promised.—A shipment of 200 tons of silver-lead ore will be started next week from the Wide West mine on Leavenworth mountain. This ore is of good grade, and will yield close to 100 oz. of silver per ton. A. L. Stephens is manager.—Work has been resumed on the Aramosa mine on Columbia mountain by A. Swanson & Co. Drilling is in progress on a 6-in. streak of silver-lead that is worth nearly \$100 per ton.—The Culley adit on Saxon mountain is being repaired preparatory to resumption of work in the face. The bore now has a length of 1100 ft.—Men are employed at the Dorie adit. Numerous caves that occurred during the eight years the property lay dormant are being caught up and extension of the adit will be in order within 30 days. It is proposed to drive 1200 ft., when cross-cutting will start to the west to connect with the Capital adit workings. T. Kyner is manager.—The Tol Reynolds property on Alpine mountain is receiving attention and occasional shipments of a lead-zinc ore are going out. The ore is consigned to the Linn mill for separation. L. B. Davenport is lessee.—The Capital Tunnel & Mining Co., controlling one of the largest mineral estates on Griffith mountain, has awarded a contract to John Connors to extend the west drift 500 ft. This will take the heading to the end-lines of the Aetna vein.—Hamilton & Co., leasing on the west drift of the Aetna vein, has a 4-ft. vein of smelting ore exposed that brings a settlement averaging \$70 per ton in gold, silver, and lead. A net earning of \$2000 per month is made.—Work has been resumed on the Queen City group of claims on Democrat mountain. Repairs are being made preparatory to extending the adit, which now has a length of 600 ft. G. W. Twagarden is manager.—The Red Oak Mining Co. has been prosecuting active development for the last several weeks.

Operations are being centred through the Sceptre adit, and there is already a fine show of ore. E. Anderson, of Georgetown, is manager.—Stephens brothers have secured a favorable lease on the greater portion of the Pelican mine, and are now employing men in repairing the various workings. It is proposed to send a large tonnage of lead-zinc ore to the Mendota mill.—It is reported that work will be resumed at an early date on the Kelly adit on Democrat mountain. This bore has a length of 2800 ft. A working fund of \$12,000 has been provided.—The Argo Leasing Co., operating the Doctor Town mine in the Daily district, will shortly start work in the construction of a mill with a daily capacity of 50 tons. The road leading from Empire station to the mines is now being repaired so that heavy machinery may be transported. Albert Hanson, of Empire, is manager.

Idaho Springs, July 18.

DOLORES COUNTY

After spending \$250,000 on development and \$75,000 on a mill, etc., also paying off a bond of \$150,000, the Rico Wellington Mines Co. is out of debt. Over \$15,000 of ore is in transit. A compressor and drills are to be installed. J. C. Jensen is manager at Rico.—The Rico Argentine Mining Co., under the same management, is to install similar machinery.

LAKE COUNTY (LEADVILLE)

When pumps arrive the La Plata mine in California gulch is to be unwatered.

Exploration in East Tennessee gulch is receiving attention. The Helen Gould adit is in over 600 ft. in good porphyry, and has opened a small vein assaying 1½ oz. gold and 22 oz. silver per ton. The Jennie June, Emma Mabel, and Gold Leaf are properties of promise.

Large shoots of zinc carbonate and sulphide have been opened in the Gambetta on Yankee hill. The monthly output of these ores is 800 and 400 tons, respectively.

SAGUACHE COUNTY

(Special Correspondence.)—Near the San Luis lakes, east of Hooper, the San Luis Soda Co. is to treat the extensive deposit of soda owned by it.—A large deposit of manganese ore has been developed by a company 14 miles east of Moffat. S. R. Miller, of Moffat, is president.—On Pole creek, near Liberty, the Golden Treasure Mining Co. is developing by adit a good gold-copper vein. Machinery is to be ordered. B. O. Roloson is manager.—Since the Rolla mine at Bonanza was sold that place is much more active than before.

Crestone, July 14.

SAN MIGUEL COUNTY

In May the Tomboy company treated 13,000 tons of ore for bullion worth \$94,000. The profit was \$28,650.

MICHIGAN

THE COPPER COUNTRY

The Calumet & Hecla reports the June outputs as follows, in pounds:

Mines	June	6 Months
Ahmeek	2,280,923	11,461,195
Alhonz	922,584	5,137,907
Calumet & Hecla	7,217,837	38,157,582
Centennial	216,919	1,269,637
Isle Royale	1,138,814	6,035,766
La Salle	69,370	632,608
Osceola	1,571,714	9,791,439
Superior	286,124	1,758,465
Tamarack	515,321	3,416,425
White Pine	302,448	2,190,472

On July 15 the Calumet & Hecla Mining Co. celebrated its fiftieth anniversary at Houghton. Everything went off well, save for a little rain which interfered somewhat. The affair

was held in Calumet park. The crowd was addressed by the general manager, James MacNaughton; Henry L. Higginson of Boston, long connected with the company; and Governor Ferris of Michigan. The parade of employees, with Mr. MacNaughton as grand marshal, consisted of 5600 men. At 2 p.m. the honor medals were distributed, after some remarks made by Rodolphe Agassiz. There were 169 gold, 38 silver, and 822 bronze medals to men who had worked over 40, 30, and 20 years, respectively, for the company.

During May the Copper Range Railroad's revenue was \$90,639, of which \$21,647 was profit. In 11 months the revenue totaled \$811,970, against \$603,094 in the previous term. The respective profits were \$146,161 and \$73,420.

MONTANA

PHILLIPS COUNTY

Fire destroyed property in the mining town of Zortman, in the Little Rockies, to the value of \$25,000 on July 8.

SANDERS COUNTY

Thirty tons of antimony ore was shipped by F. S. Houghland and partners from Thompson Falls last week. They have a good property on Prospect creek, midway between Thompson Falls and Murray.

SILVERBOW COUNTY (BUTTE)

The Trail, Grand Forks, and Greenwood smelters in British Columbia are to smelt 500, 50, and 100 tons daily, respectively, from the Bullwhacker copper mine. The smelting charges are \$3.50, \$3, and \$4 per ton, with \$4 per ton for freight from Butte. Lessees last week shipped a car of 12% ore to the East Butte smelter.

Work has been suspended temporarily at the Rainbow mine, whose shaft is down 1500 ft. The company is developing the Butte & London.

No. 2 adit of the Butte-Columbia company, at the head of Tramway gulch, is in 800 ft., and is within 175 ft. of the lode.

Electric motors, cells, insulators, anodes, and other apparatus of the Butte-Duluth was sold last week by trustees order for \$6174.

NEVADA

CLARK COUNTY (GOODSPRINGS)

According to T. H. M. Cranpton, copper minerals are more abundant in the Goodsprings district than generally supposed. They are found with certain zinc deposits, alone, with iron, and with platinum. The Green Monster has copper-lead-zinc ore, the Copper Peak copper carbonates alone, cuprite alone in the Columbia, and malachite and brochantite in the Boss platinum mine.

ELKO COUNTY

In the northern part of this county, 8 miles south of the Willow Creek dam, W. C. Davis and Salt Lake City people have opened a deposit of rich cinnabar over a length of 140 ft., and 12 ft. depth. A 10-ton plant is to be erected.

At Jarbidge the Long Hike and O. K. mines are bonded to the Sloss interests of San Francisco, while the Success and Pick and Shovel properties are bonded to the Tevis people. The Buster mine is also the subject of a deal.

HUMBOLDT COUNTY

For the Oklahoma Gold Mining Co.'s mill out from Jungo on the Western Pacific line, 30 miles south-west of Winnemucca, lumber and machinery has been bought in San Francisco. T. Ewing is president.

The Bird winze in the Seven Troughs Coalition is down to the 1725-ft. point in rich ore.

Native silver is being mined in ore from the deep workings of the Rochester Mines Co. Winze 301, known as the Codd winze, now down a trifle over 800 ft. on the dip of the east vein, produces this ore. The whole bottom of the winze is in

ore of much better than average milling value, latest assays returning over \$10 gold and 25 oz. silver per ton. The Codd winze is being sunk rapidly to connect with the raise from the Friedman adit. It will eventually be the outlet for ore from all parts of the mine.

LINCOLN COUNTY

The Consolidated Nevada-Utah company's new mill near Pioche is working to capacity, producing 500 tons of 60% zinc concentrate, and 50 tons of iron-gold-silver-lead concentrate per month.

LYON COUNTY

A dredge is to be erected at Dayton by the Rae Consolidated Gold Dredging Co. J. B. Rae is president. The E. R. Bacon Machinery Co. of Los Angeles is to supply some of the plant.

NYE COUNTY (TONOPAH)

During the second week of July, Tonopah mines produced 10,360 tons of ore valued at \$212,560; in the third week the yield was 10,139 tons worth \$208,582.

The June output of the Belmont was 230,652 oz. of silver and 2400 oz. of gold, from 12,074 tons of ore. The profit was \$116,847. The returns for 6 months total 15,344 oz. of gold and 1,448,905 oz. of silver from 75,516 tons of ore. Profits amount to \$649,673.

For June the Tonopah Mining Co. reports 9060 tons treated, 119,325 oz. of bullion shipped, and \$19,950 net profit. Work is to be extended at the Sand Grass claims, as the 70-ft. head-frame at the Red Plume shaft is to be moved there.

The Jim Butler company has decided to appeal against the recent decision in its suit with the West End, wherein the latter had a favorable judgment.

At 1260 ft. in the Extension the junction of the North Merger and Murray veins has been reached. This makes the former shoot 700 ft. long, and from 3 to 30 ft. wide.

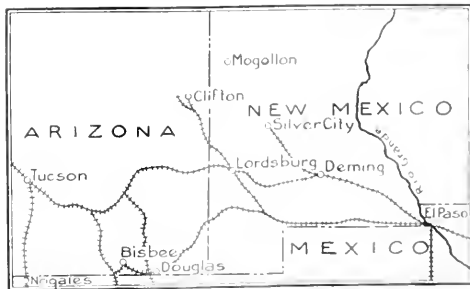
STOREY COUNTY

The United Comstock Pumping Association has commenced to unwater the north end workings to the 2900-ft. level, under water since 1885. This will re-open 200 ft. more ground. Unwatering from 2500 to 2700 ft. cost \$17,000; the proposed work will cost less. The Union shaft will be completed to 2700 ft in a few days.

NEW MEXICO

SOCORRO COUNTY

(Special Correspondence.)—Merchants and business men of Clifton, Arizona, are making a strong bid for the Mogollon



MAP SHOWING LOCATION OF THE MOGOLLON DISTRICT, WITH REGARD TO ITS TRANSPORT PROBLEMS.

business. It is said that from a survey down the El Paso river good road grades have been found. This route would give a haul to railroad of about 65 miles instead of over 80 miles via Silver City, New Mexico, and would reduce freight charges in the neighborhood of \$5 per ton.

Work is to be started by the Alberta Mining & Development Co., A. H. G. Palmer in charge, at the Alberta claims, which are favorably situated.

The Eberle mine shaft of the Oaks Co. has been unwatered. Drifts at the bottom are yielding ore for the custom mill.

The Pacific mine shaft has been re-timbered to 500 ft. Everything is electrically driven.

Abundant rains in the mountains during the past week have assured ample water supply for mines and mills, and all plants are running at full capacity. The economic importance of utilizing one of the locally available sites for a hydro-electric installation is becoming more and more apparent, and it is confidently believed some definite steps to this end will be taken in the early future on a scale sufficiently large to meet the growing power consumption of the district.

Mogollon, July 18.

GRANT COUNTY

A recent addition to the geologic map of the United States which the U. S. Geological Survey is constructing is the Silver City folio, by Sidney Paige, which describes the geology and resources of the region adjacent to Silver City, in southwestern New Mexico. It contains geologic and topographic maps and a map showing geologic structure, besides numerous photographic illustrations. The country described has long been known for its deposits of gold, silver, copper, zinc, and iron, all of which are mined. The Silver City district borders the desert region north of Deming. It is partly mountainous, partly a foot-hills country, and its geology is complex and varied. Sedimentary and igneous rocks furnish a long record of its history, in which volcanism, faulting, and folding each played a part. In recent years the development of valuable bodies of low-grade porphyry copper have added to the fame of the Santa Rita or Chino district, in the Silver City region, where for more than a century rich oxide ores of copper have yielded great returns. In the Burro mountains also deposits of low-grade copper ore are developed, and zinc mining has been stimulated by the development of replacement deposits near Pinos Altos. Turquoise, of superior quality and in extremely rich deposits, has in the past been produced in this region.

OREGON

JOSEPHINE COUNTY

The well-known Layton placer property on upper Williams creek, near Grants Pass, has been sold to the Pacific Placer Co., headed by Austin Wilson of Boston, by the heirs of the late J. T. Layton. To the 600 acres are to be added the adjoining 400 acres. There are 38 miles of ditches, delivering water with a 300-ft. head to the giants. More plant is to be added.

UTAH

BEAVER COUNTY

A 25-ton flotation plant is proposed for the Antelope Star lead mine, 12 miles from Milford. A. C. Nebeker is manager.

At the Moscow mine the shaft is down 1000 ft. During June 200 tons of copper ore was shipped to smelters, averaging 5% metal.

At a depth of 155 ft. in the Croff mine, in the Lincoln district, 8 ft. of ore assaying 49c. gold, 11.2 oz. silver, 0.27% copper, 30.2% zinc, and 21% lead, has been cut. R. R. Tanner is manager.

JUAB COUNTY

A 25-ton zinc leaching plant is to be erected at the Lower Mammoth mine at Tintic. The process of Pierre Penarot will be used. The Western Smelter Co. of Salt Lake City controls the system, and may construct the plant at Goodsprings, Nevada.

In sinking the new shaft at the Chief Consolidated, progress in the first few days was 10 ft. daily.

Profits of the Eagle & Blue Bell are increasing so much that it is thought dividends may soon be resumed.

SALT LAKE COUNTY

The Bingham-Tooele tunnel of the Utah Metal & Tunnel Co. is in 853 ft., following a porphyry dike to the limestone-quartzite contact.

The Alta Tunnel & Transportation Co.'s tunnel in Big Cottonwood is in over 2000 ft. Gas from blasting is bad, but a suction-fan has been installed at the portal to draw-off the fume.

Preliminary work for power-plant, etc., at the Wasatch in Little Cottonwood is completed, and it is expected that driving of the tunnel will be commenced by August 1.

TOOELE COUNTY

At the International smelter at Tooele, two units of the Cottrell process were started last week. This will reduce fume considerably, and several farmers have settled with the company for alleged damages to crop. Two more units will be ready in a month.

The Ophir district is producing more zinc ore than ever before. The Ophir Hill Consolidated is treating 300 tons daily.

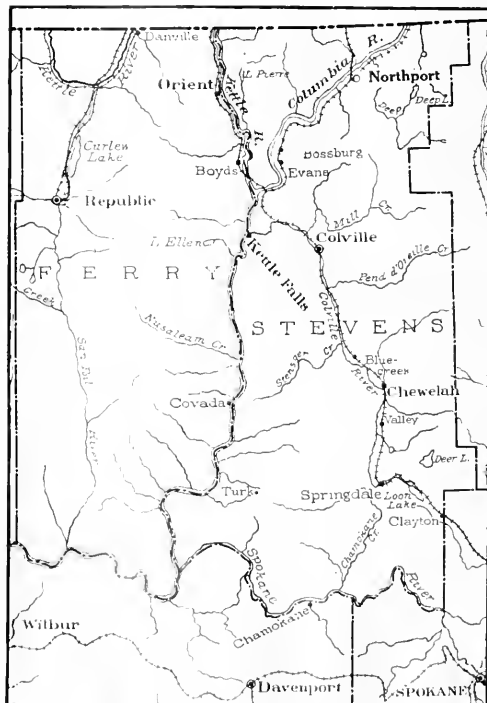
UINTAH COUNTY

In the Three States district, close to the Colorado and Wyoming borders, a rich copper property is being developed by a company of which J. T. Fitch is president, and W. O'Neil manager.

WASHINGTON

STEVENS COUNTY

The Electric Point Mining Co. near Northport closed a contract with the Trail, B. C., smelter for its entire output for one



NORTH-EAST WASHINGTON.

year, shipments to be made at an average rate of between 75 and 100 tons daily. The clean sulphide ore is to be kept separate as much as possible from the carbonate ore. All ore

containing less than 60% lead in carload lots is to be classed as carbonate, and take the lower freight and treatment rate provided by the contract.—The Kusa Spelter Co., with zinc smelters at Kusa, and Dewar, Oklahoma, and Donora, Pennsylvania, has secured a contract for one year on the whole zinc carbonate output of the Norman Mines Co., which is operating the Great Western and Last Chance mines, near Northport, and also has contracted for the product of the Jackson Basin Zinc Mines Co., operating several properties in the Kaslo-Slocan district of British Columbia, according to Newton W. Emmons, north-western representative of the Kusa company.

According to James A. Welch, president, the Norman Mines Co., operating the Last Chance and Great Western groups, six miles from Northport, will construct a mill this fall to handle the lower-grade ores from both properties. It is also announced that the company has just entered into a contract with the Ozark Smelting & Mining Co. at Coffeyville, Kansas, by which it will forward 1000 tons of lead zinc ore at a net profit of \$22.50 per ton. This ore is now being loaded at Northport and the consignment will be out before the end of August.

The outlook for practically all the companies, both development and operating, in the Chewelah district, is decidedly promising, and within the next year there undoubtedly will be a number of new shipping properties added to the list. Lack of capital to properly finance development and exploration is all that has prevented the camp from becoming recognized as one of the important copper regions of the West, but this difficulty gradually is being overcome, and nearly all the interests represented there have funds to carry their plans to a successful conclusion. The United Copper is shipping concentrate regularly. The Copper King is soon to commence ore extraction. The Security Copper shaft is down 350 ft. Prospects at the Chewelah Consolidated, Lookout, and Jumbo-Echo are said to be good.

MEXICO

An announcement made last week by the International Commission Co.'s customs department at Douglas dealt with a list of the duties fixed by the Mexican government for the exportation of various metals in the month of July. All duties are estimated in Mexican national gold. The unit of assessment is the kilogram of 2.2 pounds:

Silver bars, \$3.353 per kilo; concentrates and ores, \$4.191.

Copper bars, \$0.05712; concentrates and ores, \$0.07175; copper sheets, \$0.05455.

Lead bars, \$0.00905; concentrates and ores, \$0.01131.

Antimony bars, \$0.00454; concentrates and ores, \$0.00639.

Tungsten metal, \$0.27949; concentrates, \$0.34936.

Graphite, \$0.00166; refined, \$0.02229.

Zinc bars, \$0.07271; concentrates and ores, \$0.09098.

Tin bars, \$0.01898; concentrates and ores, \$0.02512.

Obituary

PHILIP DEBENHEIMER, who first introduced the 'square set' system of timbering into American mines, died in this city on July 20 at the age of 84. In 1860, when a vein of ore 65 ft. wide had been exposed in the Ophir mine, on the Comstock, he went from Georgetown, California, to Virginia City, Nevada, at the request of W. F. Babcock in order to overcome the difficulties of stoping ore of unusual width. He introduced what is now known everywhere as the square set, but he obtained no particular reward for his ingenuity and although respected and liked by the mining community in California he died a poor man. He made the first report on the project to bring water from Lake Tahoe to San Francisco and did much useful work in his day. He is survived by a widow. It is proposed to do honor to his memory by helping her.

PERSONAL

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

S. H. DOLBEAR has gone to New York.

JAMES T. DIXON has gone from London to Colombia.

HUBERT LANG is examining mines between Elko and Ely, Nevada.

F. L. SIZER is examining mines in Santa Cruz county, Arizona.

H. L. SWAIN and H. C. BALDWIN have come to San Francisco from Mexico City.

ALFRED H. BROOKS, of the U. S. Geological Survey, is at Ketchikan, Alaska.

HENNES JENNINGS and H. C. PERKINS are at the Fairmont hotel, San Francisco.

HARRISON A. DUNN, reported to be in prison in Mexico City, is safe at Los Angeles.

ERNEST KLEPETKO, of Anaconda, visited Houghton on his return from New York.

R. S. BURDETTE has left Guadalajara, Mexico, and is temporarily in San Francisco.

FRANK H. PROBERT has gone to Portland, Oregon. On his return he will go to Arizona.

HOWARD D. SMITH sailed from New York by the *Touraine* on July 17, on his way to London.

FREDERICK G. CLAPP of the Associated Geological Engineers is in Wyoming, and will go to Oklahoma shortly.

ROBERT H. JEFFREY has been appointed manager to the Mazapil Copper Co., at Saltillo, Mexico, in succession to the late PERCY E. O. CARR.

C. N. WHITAKER, JR., was married on June 9 to Miss Alice Wishard. He returned recently from Mexico and is now with the Empire Zinc Co., at Denver.

Phelps, Dodge & Co. announces the following promotions: WALTER DOUGLAS to be vice-president with headquarters at New York; S. W. FRECHU succeeds Walter Douglas as general manager; A. V. DYE becomes assistant-general manager; G. H. DOWELL becomes general manager of the Copper Queen Consolidated Mining Company.

LOUIS ROSENFELD, president of the Eagle Shawmut Mining Co., at Shawmut, Tuolumne county, California, died in San Francisco on July 20, at the age of 54. For over 20 years he controlled and operated the mine, one of the best along the Mother Lode, without any litigation. Those who knew him personally and in business spoke highly of his qualities.

JOHN F. CAMPION, mine operator and banker, formerly conspicuous at Leadville, died at Denver on July 17. He was born on Prince Edward island, Canada, on December 17, 1849. In 1862 he went to California with his parents. At the age of 17, toward the end of the Civil War, he enlisted in the Navy and made a good record. At the end of the War, he returned to California and started his mining career. Later he moved to Nevada and then to Leadville in 1879, the boom year. His work at Leadville was most useful. Besides being a pioneer he had enough knowledge of geology to undertake successful exploratory work. He is survived by his wife, four children, and a brother in Denver.

The U. S. Civil Service Commission announces an open competitive examination for laboratory assistant, on August 23-24. From the register of eligibles resulting from this examination, certification will be made to fill existing vacancies in the Bureau of Standards, at entrance salaries ranging from \$900 to \$1200. Applications should be filed at Washington as early as possible.

THE METAL MARKET

METAL PRICES

San Francisco, July 25.

Antimony, cents per pound.....	15
Electrolytic copper, cents per pound.....	27.50
Pig lead, cents per pound.....	7.00—7.75
Platinum: soft metal, per ounce.....	\$65
Platinum: hard metal, 10% iridium, per ounce.....	\$69
Quicksilver: per flask of 75 lb.....	\$80
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ONE PRICES

San Francisco, July 25.

Antimony: 50% product, per unit (1% or 20 lb.).....	\$1.00
Chrome: 40% and over, f.o.b. cars California, per ton.....	12.00—16.00
Manganese: 50% product, f.o.b. cars California, ton.....	12.00—20.00
Magnetite: crude, per ton.....	7.00—9.00
Molybdenum: 50% and over, per pound.....	0.60—1.15
Tungsten: 60% WO ₃ per unit.....	25.00

New York, July 19.

Antimony: The decline in the price of refined metal seems to have put a quietus on business in ore. At prevailing prices it seems impossible to import the ore from South America. No quotations are given.

Tungsten: Dealers report the market difficult to gauge, the smaller buyers being ready to pay higher prices than the large consumers. Business in 20-ton lots has been done at \$27 per unit, while \$25 has been bid for a 25-ton lot. France is reported in the market for tungsten ores at about \$20 per unit, and wants a large quantity.

EASTERN METAL MARKET

(By wire from New York.)

July 25.—Copper is quiet though stronger; lead is dull, prices are nominal; spelter is stronger abroad, sellers are reserved.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
July 19.....	25.00
" 20.....	25.00
" 21.....	25.00
" 22.....	25.00
" 23 Sunday.....	25.00
" 24.....	25.00
" 25.....	25.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.69	24.30	July	13.26	19.09	....
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	....
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	....
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	....
May	13.97	18.71	29.02	Nov.	11.75	18.88	....
June	13.60	19.75	27.47	Dec.	12.75	20.67	....

Mass Consolidated pays its initial dividend, of \$1 per share, on August 15. This is equal to \$100,000. Champion Copper is to pay \$6.40 per share. The first dividend of the First National Copper Co. will be 25c per share on 600,000 shares.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
July 19.....	62.12
" 20.....	62.75
" 21.....	63.37
" 22.....	63.37
" 23 Sunday.....	63.37
" 24.....	63.37
" 25.....	62.87

Monthly averages

Monthly Averages							
1914.		1915.	1916.	1914.		1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	....
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	....
Mch.	58.91	50.61	57.89	Sept.	53.75	48.77	....
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	....
May	58.21	49.87	74.27	Nov.	49.12	51.88	....
June	56.13	49.03	65.04	Dec.	49.27	55.34	....

Writing at the end of June, Samuel Montagu & Co. of London

states that the cessation of China sales created a firm tone, resulting in a rise. After certain Indian Bazaar operators had taken profits on re-sales during the early part of the period under review, the improved outlook of the market encouraged other Indian dealers to make moderate purchases on speculative account. Thus a measure of competition with coinage orders arose and a more robust tone was the outcome.

Domestic consumption is increasing considerably, especially in photography. The Eastman Kodak and International Silver use 4,000,000 and 3,000,000 oz. yearly, respectively.

It is estimated that Mexico's silver production has dropped to the rate of 25,000,000 oz. per annum, about 35% of normal. It is said that Mexicans are hoarding silver, rejecting the new Carranza currency. Mining companies report that each month 25% of wages disappears from circulation.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
July 19.....	6.30
" 20.....	6.30
" 21.....	6.30
" 22.....	6.30
" 23 Sunday.....	6.30
" 24.....	6.30
" 25.....	6.30

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	....
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	....
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	....
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	....
May	3.90	4.24	7.38	Nov.	3.68	5.15	....
June	3.90	5.75	6.88	Dec.	3.80	5.34	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
July 19.....	9.25
" 20.....	9.50
" 21.....	9.87
" 22.....	10.12
" 23 Sunday.....	10.25
" 24.....	10.50
" 25.....	10.50

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	....
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	....
Mch.	5.12	8.10	18.40	Sept.	5.16	14.14	....
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	....
May	4.91	17.03	16.01	Nov.	5.01	17.20	....
June	4.81	22.20	12.85	Dec.	5.40	16.75	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date.	July 11.....	July 18.....	July 25.....
June 27.....	\$5.00	\$5.00	\$8.00
July 5.....	\$5.00	\$5.00	\$8.00

Monthly averages

Monthly averages							
	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	....
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	....
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	....
Apr.	38.90	77.50	111.60	Oct.	53.00	92.90	....
May	39.00	75.00	90.00	Nov.	55.00	101.50	....
June	38.60	90.00	74.70	Dec.	53.10	123.00	....

TIN

Prices in New York, in cents per pound.

Prices in New York in cents per pound						
Monthly averages						
	1914.	1915.	1916.		1914.	1915.
Jan.	37.85	34.40	41.76	July	31.60	37.38
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00
May	33.29	39.28	49.10	Nov.	33.51	39.50
June	30.72	40.26	42.07	Dec.	33.60	38.71

Tin is quiet at 38.50 cents.

Eastern Metal Market

New York, July 19.

ZINC

Zinc is the one metal that shows any betterment with regard to buying or prices. Galvanizers have taken a good quantity for shipment throughout the year, and the quotation is a little stronger.

Copper continues practically lifeless, and concessions are greater, with some reported on the part of producers.

Lead is dull and weak.

Tin is getting low enough to interest consumers, despite the fact that most of them are well covered.

Antimony is stagnant.

Aluminum is unchanged at 59 to 61 cents.

It is not a bad thing that the metals are approaching a more rational basis with regard to prices. Even at below present levels, big profits are possible, and with costs nearer normal a large amount of domestic business is likely to be released, as exemplified by zinc. Many prominent members of the trade are frank in saying that excessive war prices are not healthy.

Slight shading of prices is beginning to appear in some steel products which have been so high as to repress domestic demand, this being particularly true in the case of structural shapes. Jobbers in this field have led the way by under-selling the mills. Export sales continue to grow in magnitude. Foreign consumers are contracting for shell-steel, beams, steel rails, plates, steel-making pig iron, barbed-wire, spikes, steel axles, etc., all of which will have a supporting effect on the market. The lower cost of zinc is having its effect in galvanized-steel products, galvanized sheets having sold down to 4.25 cents.

There is a vast amount of second-hand metal-working machinery on the market, and tool builders are wondering what effect its existence will have on their future business.

COPPER

The market continues practically lifeless, but with second-hand offering substantial concessions there should come a change before long. It already is reported that certain producers are looking for business, and that they are willing to take prices lower than those for which they have been holding, although they are not yet willing to meet re-sale prices. On the other hand, it still is insisted that they have contracts aplenty to keep them busy until September, at least. The situation is so mixed that it seems the forerunner of a change of some kind. Electrolytic can be had easily at 25c. for prompt delivery, and probably at 1c. less, while forward deliveries are quoted at 23.50 to 24c. The War contractors and large consumers are unquestionably well covered for this quarter. A little review of some of the products into which copper enters may be interesting: The brass mills would like to have more demand for the larger sizes of brass rods for which they ask 29c., or less, per lb. Sizes under $\frac{1}{4}$ in. are still held at a premium. Sheet brass is as hard to procure as it has been since the War started, the mills having orders booked, which, in conjunction with the known requirements of their regular customers, will keep them busy for some months to come. High sheet brass is quoted at 38 to 39c. Brass wire is not as difficult to obtain as sheets, and is quoted at 38 to 42c., delivery in three to four months. The mills which make brass and copper tubing are loaded up, seamless copper and brass tubing being quoted at about 44c. Hot-rolled sheet copper is 37.50c., and cold-rolled, 38.50c. The London market for electrolytic is weak, and since the last report has declined 95 European statistics received here this week show that stocks in Great Britain and France remain about stationary. On July 15 they totaled 7464 tons, against 7603 tons June 30, and 6459 tons, June 15. A slight decrease will be noted. Exports, July 1 to 18, totaled 15,235 tons.

This is the one metal that has shown activity, and an improvement in price. Late last week, with the spot market at about 9c., and some rumors of concessions slightly below this level, galvanizers who for some time had been watching the market closely became active, and they are reported to have taken a good tonnage for delivery to the end of the year. The movement might have been of greater proportions had it not been for the unwillingness of a goodly number of the producers to sell into the future. The buying began at a shade under 9c. New York for spot, and 8.75c. St. Louis, but prices quickly stiffened and mounted to about 9.25c. New York, by July 15. September was taken at around 9c., St. Louis, and October at 7.75c. Consumers had been vainly hoping that futures would drop to 7c. The spot quotation yesterday was about 9.25c., New York, and 9c., St. Louis, and the buying had not entirely ceased. August was quoted yesterday at 9c. St. Louis, and September at 8.75c. The brass mills have not been active as buyers. The price of sheet zinc is unchanged at 15c. f.o.b. smelter, in carload lots. The London quotation for spot zinc is stronger at 41s. an advance of 4d. in the week. Exports in 18 days were 4497 tons.

LEAD

A few thousand tons of lead have been sold for export, but the domestic demand has continued quiet, and prices are sagging. The A. S. & R. Co. has adhered to 6.50c. New York, and 6.42 $\frac{1}{2}$ c. St. Louis, but announcement of a reduction in its prices is expected at any time. Quotations of independent producers and re-sellers have declined steadily, and they undoubtedly have taken what little business has been doing. Their quotation yesterday was 6.25c. New York, and 6.10c. St. Louis. There is no new war demand, and features are few, but one which may be mentioned is a railroad strike in Spain which may make deliveries from that country somewhat difficult. If the strike is serious it may cause some of the warring nations to look here for lead. Meanwhile the market is a waiting one, consumers expecting to see lower prices. The London quotation for spot lead is practically unchanged since the last report, namely, £28 10s. Exports from the 1st to 18th amounted to 2046 tons.

TIN

Heavy arrivals and the well-supplied condition of the consumers have conspired to make a quiet market, with consequent lower prices. Whereas a week ago spot Straits tin was quoted at 38.50c., it was to be had yesterday at 37.25c. Banca can be had at a fraction of a cent less. At present price levels, consumers are showing interest and it would not be surprising if a buying movement of moderate size should come. While most of the consumers are well supplied, there always are those who will buy at a bargain and in the case of tin, it also is to be considered that its consumption is on a record-breaking basis. Never before, perhaps, have the tin plate mills been so busy. Not only is the domestic demand good, but export sales at premiums are numerous. The arrivals of pig tin this month aggregate 1580 tons, and there is about 2100 tons. The spot Straits quotation at London yesterday was £161 10s., against £169 15s. a week ago, indicating weakness.

ANTIMONY

All that can be said about this metal is that it seems to hold no interest for buyers. Chinese and Japanese grades were quoted yesterday at 11c. duty paid, and at 11 to 11.50c. in bond. One good sale is recorded, a Canadian nonferrous maker having taken a round lot, but the quantity was not sufficient to halt the trend of the market.

Chart for Computing Excavations

The accompanying chart, which is taken from the *Excavating Engineer*, will be found useful in computing the approximate volume of excavations with vertical sides, and can also be adapted to computations for sloping sides. The lines on the chart show the method of computing the volume of an ex-

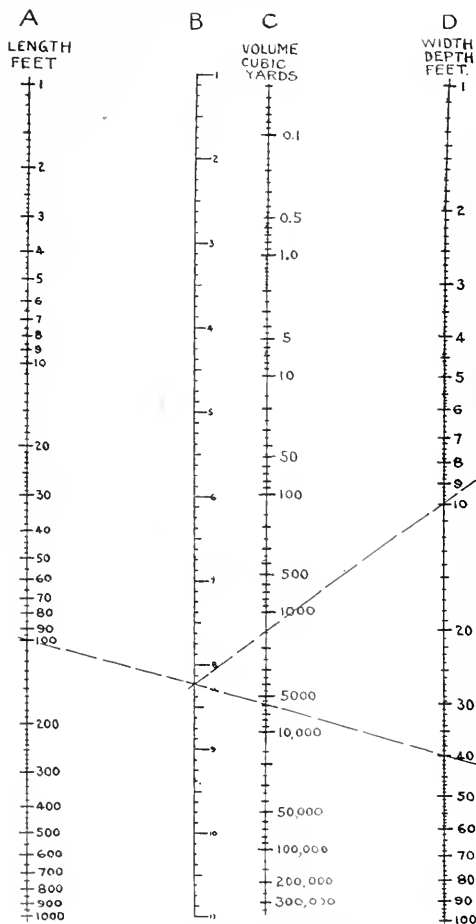


CHART FOR COMPUTING EXCAVATIONS.

excavation 10 ft. deep by 40 ft. wide by 100 ft. long. Draw line from point 100 in column A to point 40 in column D and mark the intersection with column B. From this point draw line to point 10 on column C. At the intersection with column C read 1500 cu. yd., the volume of the excavation.

Where two dimensions are alike, the work is still simpler. If the excavation is 40 by 40 by 100 ft., it is only necessary to draw the line from 100 on column A to 40 on column D and read the quantity, 6000 cu. yd., directly from column C.

For a cut 100 ft. long, 40 ft. wide at the bottom, 60 ft. at the top, and 10 ft. deep, proceed as for a cut with vertical sides 50 ft. wide.

CRUDE GYPSUM mined in the United States during 1915 totaled 2,447,541 tons. All products totaled \$6,596,893.

BOOK REVIEWS

ANNUAL REPORT of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1915. Charles D. Walcott, secretary. P. 544. Ill., maps, index. Washington, D. C., 1916. May be obtained through this office; price, \$1.50.

As usual, the report of the Secretary and the 22 contributors' papers are of considerable interest and variety. The latter include from astronomy to submarine signalling, primitive life to the linguistic areas of Europe.

LAND AND MARINE DIESEL ENGINES. By Giorgio Supino. P. 309. Ill., plans, index. Charles Griffin & Co., London; J. B. Lippincott Co., Philadelphia, 1915. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$3.75.

This is the third work on Diesel engines that we have received for review in the past few months. The author, an Italian engineer of repute, died in 1913, just as the volume was printed. Translation in English is by A. G. Bremner and James Richardson of London. The Diesel engine is becoming more and more of importance in machine-shops, power-plants, and on vessels. A large number of such motor-driven boats are continually visiting American ports. The trip of the German submarine merchant-boat across the Atlantic was made possible by the Diesel. Part I of this publication discusses Diesels for all services, their fuel, efficiencies, and the like. Part II deals with foundations, bed-plates, engine-framing, cylinders, shafting and rods, valves and gear, reversal of the engine, fuel pump, compressors, marine installations, testing, and rules for classification and survey of Diesels. Interspersed are 370 illustrations and 19 drawings, making the whole of practical value to the modern engineer.

METALLURGY OF STEEL. Metallurgy by F. W. Harbord; mechanical treatment by J. W. Hall. Vol. I, p. 532, ill., charts, plans, index; Vol. II, p. 441, ill., charts, plans, index. Fifth edition. Charles Griffin & Co., London; J. B. Lippincott Co., Philadelphia. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$12.50 for the two books, not sold separately.

There is much excellent material in the 933 pages of reading matter in these two volumes, but space available will permit of only a brief review. Since the last edition there has been no special development in iron and steel manufacture, but steady progress was made in details of practice. These advances are discussed, including the manufacture of nearly chemically pure iron from phosphoric pig-iron in the basic open-hearth furnace, also methods of producing sound ingots and for decreasing segregation. Armor-plate making and theories of hardening steel are brought up to date. The object of the present work is to furnish a full description of the various branches of steel manufacture, both from a metallurgical and an engineering standpoint, as well as to discuss the physics and chemistry of steel in relation to its manufacture. The work has been divided into four sections: namely, manufacture of steel, mechanical treatment of steel, re-heating, and finished steel. The chapters include Bessemerizing, basic furnaces, gas producers, open-hearth furnaces, steel castings, crucible steel, electric smelting, influence of other metals on steel, microscopical examination of metal, plans of typical steel plants, rolling and other mills, power, forging, tube-making, wire drawing, corrosion, and many other important phases of the steel industry. The 571 illustrations are of practical value. American, English, and European practice is compared. Generally the work should be of value to all steel makers. The index of 30 pages by C. O. Bannister is excellent.

EDITORIAL

T. A. RICKARD, Editor

GOLD imports continue at an extraordinary rate. Between January 1, 1915, and July 24, 1916, or slightly over 18 months, the grand total of gold brought into the United States is \$688,877,000, or more than all the gold produced by the mines of the United States from 1909 to 1915. The proper sequel to this is expansion of trade abroad.

BETWEEN August 9 and 12 the Pacific division of the American Association for the Advancement of Science will hold its annual meeting at San Diego. Among the societies included is the Cordilleran Section of the Geological Society of America, as well as the astronomical, entomological, and ecological societies of the Pacific Coast.

FIRES are common during these hot months, endangering mining plants. We regret the bad luck of the Mammoth and Miami communities, where destruction of property has followed upon the ignition so easy when grass and brush are as dry as tinder. In both cases, however, the principal mining equipments escaped destruction. We commend the article on fire insurance by Mr. C. T. Hutchinson, in our issue of June 24, to the attention of mine managers.

TWO YEARS of the pentecost of calamity have passed and the world hopes that the end is in sight. It is estimated that the total cost to all the belligerents is 55 billion dollars. That is the smaller item, the major is the loss of 5,000,000 killed, 5,000,000 crippled, and 5,000,000 imprisoned. Whatever our sympathies, we may unite in hoping that those responsible for this organized calamity will be blighted to all eternity. Those of us who are detached spectators may also join in sympathy and respect for the examples of devotion and self-sacrifice that the nations of Europe have shown to this material civilization.

THE proposed tax on the revenue of the copper companies has aroused protest among those threatened with the unexpected impost. A concerted effort is being made to defeat this selective legislation, largely on the ground that it is unfair to tax copper and not other products, such as cotton, steel, and spelter, which also are used in the manufacture of munitions. It is estimated that the tax would collect \$15,000,000 from the producers of copper and its alloys for the calendar year 1916; and it is calculated that the profit of the industry will be about \$300,000,000 this year. The domestic output of copper is expected to be 800,000 tons, of which

about one-half will be consumed at home. During the 18 months preceding the War, Germany received 240,000 tons of copper from this country. Senator W. A. Clark and other authorities on the subject condemn the tax while they predict a continuation of the heavy demand for copper when peace is declared, anticipating large purchases by Germany and other countries engaged in the work of reconstruction, besides a growing consumption on this side of the Atlantic. We share these anticipations.

Since the above was written we have learned, from Washington, that the Senate Finance Committee has struck the copper tax from the omnibus revenue bill and it is considered probable that the leaders of both houses of Congress will agree to drop the tax, having been convinced that it is unfair.

CONDITIONS in Mexico are unchanged. Señor Carranza talks of resigning, in order that he may present himself for election to the presidency. Any election will be worse than the customary farce while disorder continues to prevail over the larger part of Mexico. The negotiations for a conference proceed in a leisurely way, and it is quite likely that these preliminaries plus the conference and the negotiations to follow may last until the first Tuesday in November has come and gone. Meanwhile Pancho Villa is on the rampage and another party, the Legalista, is hatching a new revolution under cover of Texan hospitality. The publication of the diary of Mrs. Nelson O'Shaughnessy and the letters of Mr. Henry Lane Wilson afford further testimony to the fact that the Mexican political morass has no bottom. As we go to press the speech of acceptance by Mr. Hughes is published. It should please those interested in Mexican affairs. Particularly we like the statement: "It is most unworthy to shrug those who have investments in Mexico in order to escape a condemnation for non-performance of duty."

JIGS constitute a comparatively new addition to the apparatus annexed to a gold dredge, but our readers heard of the innovation about two years ago, when Mr. James W. Neill described the device, which he invented, in our issue of November 28, 1914. Since then the jig has been applied successfully on several dredges. In this issue we publish a description of the device, and the use of it, by a detached observer, Mr. Howard D. Smith, who has taken a good deal of trouble to ascertain the facts. Those with experience in such matters will understand the difficulty of accurate sampling on a dredge and the care necessary to ascertain just what the inter-

position of such a device as a jig is accomplishing. Mr. Frank Griffin, long honorably connected with dredging practice, is responsible for the introduction of the jig at Natoma, and to him Mr. Howard Smith and ourselves are largely indebted for the information now published. We hope that at an early date Mr. Griffin will be in a position to furnish further details.

SPELTER has stopped its retrograde movement, but not before a price of 8 cents had been touched. We agree with our contemporary at New York that this lowest recent price is comparable with the 5-cent quotation of the ante-bellum period in being close to the cost of production. The increased cost, due to higher wages and the advance in the price of materials, has made it hardly more profitable to supply spelter to an 8-cent market than formerly to one that paid 5 cents per pound for the metal. The hurry of production incited by the needs of the munition-makers has tended to decrease the efficiency of labor and to lower the metallurgical extraction. These defects will be overcome in time, perhaps before the present margin of profit is wiped out, but the get-rich-quick phase of spelter production is nearing an end. Meanwhile it is an ill wind that blows no one good; the galvanizing trade is recovering as the price of the metal renders its use profitable for this purpose. For eight months the manufacture of galvanized iron has been crippled by the cost of the chief material, decreasing output by a third. Conditions more nearly normal are at hand apparently.

HARD LUCK has befallen the Tennessee Copper enterprise. When an insistent demand for sulphuric acid was made in the early days of the War, it was expected that this company would be able to take full advantage of the opportunity. Unfortunately a contract running to 1920 had already been made with the International Agricultural Corporation for the delivery of acid at a low price, but the collapse of the cotton market killed the Southern demand for fertilizer and the Agricultural Corporation tried to get out of its obligation to buy the acid. When, however, the price of acid began to soar, in consequence of war-orders, the two companies reversed their positions, the Agricultural Corporation holding to its contract like grim death in the prospect of re-selling the acid that the Tennessee had agreed to deliver. This tangle had been almost forgotten when, on March 21, a fire at Copperhill destroyed the plant in which trinitrotoluol, a powerful explosive, was being made for the Russian government, that Government having advanced \$1,500,000 for the construction of the plant. Whereupon another difference of opinion as to responsibility arose and the Russian government filed suit to recover the money advanced. Still later came the news that the acid-chambers had been closed-down during the spring in order to permit thorough repairs. The mines of this company are in the extreme south-eastern corner of Tennessee near the boundary of Georgia and North Carolina. Suits started by the State of Georgia

over damage to vegetation led to the building of the acid-making plant. During 1915, the Tennessee Copper Co. produced 12,750,148 lb. of copper from pyritic ore yielding 27 pounds of copper per ton. The output of acid last year was 210,666 tons of 60°B., but this rate should be much increased when the new addition to the plant is at work. Over \$5,000,000 in dividends has been paid since 1903. Not so much is heard of the Ducktown Sulphur, Copper & Iron Co., an older English company that operates an acid plant, smelter, and mines in the same district. Their output of copper is about half that of the Tennessee Copper Company.

SHASTA county has been the scene recently of two or three strikes that were settled amicably in short order. It appears that the men employed by the three principal copper-mining companies demanded an increase of 50 cents per day so long as copper sells for 15 cents or better. They preferred this arrangement to bonuses based on a sliding-scale graduated by the price of the metal. It looks as if they had made up their minds that any price much above 15 cents would not be lasting and preferred to lose the chance of a bigger bonus in order to assure themselves of steady wages at a fixed increase. This may prove wise, but we regret the discarding of the sliding-scale, because it involves losing an automatic method of adjusting wages in some sort of proportion to the profits made by the employer. It is easy and pleasant to raise wages in times of prosperity; it is difficult and unpleasant to cut them down when times are bad. That is when trouble begins. However just and reasonable the average miner may be, his leaders have as yet shown too little sense of fair-play to warrant the expectation that a lowering of the wage-scale when copper drops will be effected without friction and opposition. That is why we regret the passing of the sliding-scale at the Shasta mines and smelters.

Engineers and Business

We publish a letter on this subject. It deals with an important phase of professional life. Several public utterances recently have bewailed the narrow horizon of the engineer and his limited scope as a citizen. The suggestion has been made that he is too self-centred, that he thinks parochially instead of imperially on human affairs, that he ought to emerge from his self-made shell and bestir himself as a man and a citizen. With much of this we agree. Perhaps the greater participation in business, as distinguished from technology, and the larger assumption of executive, as against consultative, functions will work to that end. There does not seem much reason for criticizing the engineer in this regard; he appears to be gaining ground in the council-room and on the quarter-deck of enterprise. The names of a number of successful men come to mind as having proved themselves possessed of unusual financial sagacity and executive ability in connection with big enterprises.

Technically educated as they were, they have shown themselves more clever in the counting-room than the ordinary business-man and more skillful in finance than the average banker. An able man generally does not take long to ascertain his highest aptitude and he becomes successful when he has the opportunity to display it effectively. It is at least as true that many engineers make a mess of their careers by mixing in speculation and promotion for which they have no fitness, meanwhile neglecting the purely technical work for which they are peculiarly adapted by inherited quality and special training, as it is that some of them miss the chance to become rich quickly by keeping themselves aloof from the financial side of the industry. No; we need not press the idea of further participation in this essentially tricky and morally dangerous annex to professional life. We prefer to pass to the next suggestion, namely, that the engineer fails to let people know what he can do and thereby misses the chance not only to win clients or employers but to take a larger share of the world's work. That is more urgent. We live in a noisy world, full of assertiveness and pushfulness. The philosophic, which means the wise, man recognizes that to be effective he must adapt himself to the flux of phenomena called life, he must be in harmony with the conditions constituting this complex mode of living we call civilization. To be "a flower born to blush unseen" is a poetic destiny, but it laughs at our notions of virility. Edmund Garrett, one of the great journalists of our time, used to say that two things made life worth while: friends and the hope of being effective. It seems a far cry from so noble an expression to the word 'advertising,' but the fact remains that a man can become effective only by co-operation with his fellow-men, and to get the chance of being so he must become known to them as one whose aid is worth having. Thus we arrive at the idea that the proper study of mankind is man and the cognate idea that the knowledge of men is at least as useful as, if not more useful than, the knowledge of things. We have advised young engineers frequently to become 'acquainted' with the members of their own profession and with the mine-operators, having in mind the notion that such acquaintance would be likely to furnish opportunities for work and employment. Personal acquaintance is a great factor in life and it comes into play in most unexpected ways. Those who read the interviews we have published with the notable men of the profession, and those who will read others that are to follow, will detect how a career can receive a decisive diversion or a fateful direction in consequence of a chance meeting with a forceful personality on a train or steamship. To take the trouble to meet many men means an increase in the chances of meeting one that will be a friend indeed. It is a way of becoming known. There are others. There is the mental acquaintance that follows from the writing of something that many other men will read. Of course, we know scores of instances in which the publication of a sensible article or paper on a technical subject has called attention to a man's—not always a young or hereto-

fore unknown engineer's—ability or capacity in a given direction. We note, for example, with interest, how Mr. E. T. Mellor's recent paper on the geology of the Witwatersrand has been followed so soon by the announcement that he has been appointed consulting geologist to the Rand Mines and Central Mining corporations. We give away no secret when we mention that the preparation of the paper on the surficial signs of copper, by Mr. Frank H. Probert, and the delivery of it on invitation as a series of lectures, let to the offer of the professorship in mining at the University of California; and those of us who belong to the older generation know how the writings on copper smelting by Dr. Edward D. Peters led first to an important and highly remunerative engagement as metallurgical adviser to the Mount Lyell company, and subsequently to the professorship at Harvard, where Dr. Peters has been enabled to find his true *milieu* and fulfill it with rare distinction. Instances could be multiplied. In smaller ways a large number of men, every year, emerge from the rank by writing something that stamps them as intelligent observers or careful experimenters. That, it seems to us, is one of the most effective methods of gaining prominence honorably. We have no patience with those that claim a superior kind of modesty or a sanctified sort of diffidence by abstaining from appearance in print or from taking part in public technical discussions. Usually we have found such mock-modesty a necessary cloak for lack of knowledge or inability to convey ideas, and not the scholar's shyness or the demureness of a scientific intellect. There are those that write too much, and an editor by force of circumstances is one of them, but the number is small. There are those that write to fill space and they are a weariness of the flesh, but they are discovered before their ravages can extend far. We conclude therefore that among the methods whereby an engineer can 'advertise himself,' as it is phrased frankly, or, as we prefer to put it, become known honorably, none is so useful to himself and to others as the occasional writing of an article describing something he has seen or done. When he does it, he shakes hands mentally with a host of new acquaintances among whom presently he will discover several friends.

Directors

The director of an American mining company does not hold a position either of legal responsibility or of financial profit exactly the same as that of the corresponding official in a British company. In England, thanks to the Companies Act, the duties and obligations of the members of a directorate are clearly set forth in great detail, minutely safeguarded by law, and that is why perhaps directors are better paid for their services. An American director does not regard his appointment or election as a matter of gain, because usually the emolument is restricted to a fee of five dollars for attendance at each meeting. Even when as much as \$20 is paid, the

sum is rarely a factor of importance to the individual concerned. In England the fee used to be a guinea, and that is how the term 'guinea-pig' became applied to those who sat on many boards without evincing obvious fitness for their, often self-sought, duties. Now the director in London receives a regular payment, which is almost a salary, ranging from £100 to £200, or even £500, per annum, with £200 to £500, or even £1000, for the chairman. Some men are directors or chairmen of a sufficient number of companies to win a living therefrom, their income from this source running into several thousand pounds per annum. That is one reason why the board usually consists of a small number, generally five or seven, including the chairman. But multiple directorships constitute an absurdity, if not a scandal, there being several gentlemen who are on more than twenty different boards. At £200 apiece that would be equivalent to £4000 or £5000 per annum. The amount of money paid, of course, is not the main point of objection; it is the obvious inability of any man to give proper attention to such a number of enterprises. While a few may make a livelihood out of directing company affairs, it is probable that their presence at the council-table is valuable to them chiefly because it puts them in a position to safeguard the property in which they have placed their own or their friends' money. A smaller number, we regret to add, find it advantageous to be on a board because it enables them to obtain the first information from the mine and use it for profitable share-dealing. In this country boards of directors are much larger, partly because a large directorate is not an expensive luxury and mainly because it is deemed desirable to give representation to divers groups of shareholders. The American Smelting & Refining Company has 30 directors, of whom five belong to the Guggenheim family. The United States Smelting, Refining & Mining Company has 19 directors; the United States Steel Corporation, 18; the American Zinc, Lead & Smelting Company, 15. Undoubtedly the scattered and varied holdings of the big corporations explain the bigness of their boards and the desirability for having a large variety of talent and information at hand in the council-room. Actual control is vested in an executive committee consisting of heads of departments. The boards of these big mining and metallurgical corporations consist largely of members of the staff, none of whom receives any fee for serving as a director. Indeed the number of directors not connected with the actual management of the enterprise tends to become relatively small. The Granby Consolidated has 13 directors; the Utah Copper, 15; likewise the Inspiration; the Anaconda has 9; but the purely mining companies have smaller boards; thus the Goldfield Consolidated has 7 directors, the Butte & Superior and the Homestake have 5 each. The Calumet & Hecla, which is almost a family affair has five on the board, one of them being the resident manager; the Hollinger has the same number, two of them representing the Tinnius family, which has been associated with the enterprise from the very beginning. In several cases the general manager is a director.

This is a wise practice and is only hindered by the fact that the mine usually is several days' journey from headquarters. The responsibility for the technical operation and for the final result, that of making money for the shareholders, rests chiefly on the manager; therefore it is fair, and it is wise, to put him in full possession of the ideas and confidence of those 'higher up.' While recognizing the wish to give representation to groups of shareholders, it is still a pity that responsibility should be divided among so many. The character and the ability of a group of men is much below the average of them. In the last resort, it is usually one dominating personality that settles the policy of a company and directs its destiny. On most boards there are several passengers. Those that take their responsibilities seriously and act as trustees for the shareholders are few; the majority think they are doing well enough when they protect their own interest and that of the friends whom they represent; but the interests of these may not be identical with that of the minority shareholders. For this defect in company management there is no apparent remedy, except the election of men of high character, and of that there can be no assurance so long as selection is based mainly on property qualification. It remains a serious blemish in collective speculation, such as the operations of a mining company, that the men in charge are not selected for their special fitness. The ideal management would be a managing director, an assistant, and the resident manager. The assistant to the managing director might be the consulting engineer. All of them should be paid handsomely and be under obligation not to play the share-market, so that the proprietary, that is, the whole body of shareholders, might be assured of undivided attention to their business. The more the general direction of a complex technical enterprise is in the hands of bankers, brokers, and book-keepers, the less it is likely to achieve its purpose, which, in mining, is to make money out of the exploitation of mineral deposits. There should be a profession of directors, men qualified by training and experience to conduct the general affairs of industrial enterprises. The present writer remembers his first contact with a board of directors; he had supposed that they would be men chosen, of course, on account of their unusual sagacity; he expected to face a group of retired mining engineers or men otherwise versed in the matters to be discussed. He will never forget his disillusionment, when, traveling from California to London, he found his directors were a lot of duffers, one of them titled, all of them supremely ignorant of the matters in hand, and the only one that had even seen a metal mine, through a telescope, was the most unpractical of the lot. That was many years ago. In those days a companion picture might be found in New York. On both sides of the Atlantic these things are done better now; but still it seems a waste of time and of good brain-tissue to put persons wholly unversed in technology on the board of a mining company and to entrust the direction of its affairs to a mixed aggregation so numerous as to scatter responsibility rather than crystallize decision.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matter pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

The Flotation Process

The Editor:

Sir—I have read with appreciation the lucid account of the development of the patents and of the mentality of the patentees which appropriately appeared in your issue of April 1. Perhaps the following description of a process used by me for some time past may be of interest. My first use of it anticipated all the ruling patents except that of Mrs. Carrie Everson, but unless the Colorado Scientific Society unearths further biographical details it would be difficult to cite her in support of prior use. On the other hand, it resembles the more recent developments of the process to a remarkable degree. The selective agent used was an oil-residue obtained as a by-product in the manufacture of nitroglycerine. The quantity used was minute; I can give no actual figures, but a small supply lasted a long time. Atmospheric air was introduced by vigorous agitation, resulting in the formation of a froth that was removed by a form of scraper-conveyor specially made for the purpose by a well-known Sheffield firm. My earlier experiments were not uniformly successful, values (permit the word in this connection) tending to accompany the waste matter, and necessitating the occasional use of alum as a corrective. Apart from this no chemical agent was employed. Now, Sir, in view of recent and pending litigation, would your advice be to grow whiskers, or to run the risk of an injunction and an action for the recovery of royalties?

R. T. HANCOCK.

Jemaa, West Africa, May 28.

[Grow the whiskers; they will be handsome. An injunction and the attempt to collect royalties will prove unpleasant and unprofitable. Dedicate the process to the mining industry and feel proud of your abrogation.—EDITOR.]

The Engineer and Business

The Editor:

Sir—The relation of the engineer to business continues to interest both engineers and business-men. At the inaugural meeting of the Engineering Section of the Natal Society for the Advancement of Science and Art in Durban, South Africa, on May 19, the chairman, J. Roberts, said in part, "The business-man generally found at the head of manufacturing concerns is likely to be only superficially informed on the technical details of the business. In some cases the technical man knows that if the

control were placed in his hands the final result would be improved. In the majority of cases, however, the situation is accepted as inevitable, with the result that many times a manufacturing proposition quite sound on the technical side fails from the fact that the control is in the hands of one who cannot conduct the business portion sagaciously. We know of men with only a technical training who have been put in charge of purely selling concerns and who have turned a struggling business into one yielding good profit with quite remarkable expansion. Only an engineer can realize what class of machinery or tools is most suitable to the conditions of the market and how the standard article can be advantageously modified to suit conditions."

Mr. Roberts's argument in full contends that an engineer's training fits him to direct business matters and cultivates in him a capacity for organization. To this opinion many business-men will undoubtedly demur, just as many of the old style of bankers in Wall Street are said to be looking askance at the advertising methods and foreign connections of the National City Bank of New York, the greatest bank in the country, the president of which, Frank A. Vanderlip, secured much of his training while the financial editor on a Chicago newspaper.

In the *Engineering Magazine* for July, is an article with a good deal of sense, even if written in a colloquial style. The author, Leonard M. Cox, suggests that engineers should broaden their outlook to the bigger things of business. He advises them to "take active interest in all public matters; to make a practice of forming judgment on large affairs and then check up in the light of subsequent events; to discuss politics and business with men who know." Mr. Cox adds that "the engineer who talks to his board of directors in technical terms is making a mistake. They want a man who can talk to them in their own language of bonded indebtedness, amortization, fixed and operating charges, and who can decide upon all technical problems involved without obligating his clients to admire his erudition. * * * In the breast of many engineers is a genuine lust for analysis, for the solving of unusual problems. It is as fascinating as chess, and like chess it can absorb spare time and thought that the large-calibre man can afford to give it. A certain young engineer had been selected for promotion to a position of superintendent, when a tempting bit of difficult analysis proved his undoing. The young engineer forgot his executive duties at once and worked day and night on a detail of problems and stresses. The result was a unique and original solution

for maximum economy, a saving of perhaps \$35—and his ultimate transfer to the drafting-room!"

These opinions may be a trifle exaggerated but to a measurable extent similar thoughts are exercising the minds of most men engaged in the mines and industries of this country. The *Journal of Electricity Power and Gas* has stated editorially that the engineer is a man who *ipso facto* has eschewed advertisement and salesmanship. This is not so. Elbert Hubbard, I think it was, said that "advertising is letting people know what you can do, and if you can do anything out of the ordinary, it is of no value to you unless you let people know that you can do it." As expressed by a writer in the July Bulletin of the Canadian Mining Institute, "Merit's no good if no one ever tells." While advertising and salesmanship cannot be applied to engineering to the same extent as other industries, and while the advice of *Engineering & Contracting* that "if you want to attract attention, get in front of people and bother them" is not to be commended, yet a good deal more could be done by engineers to strengthen their profession than has been usual in the past

P. B. McDONALD.

Berkeley, July 15.

Swelling Ground and the Panama Canal

The Editor:

Sir—The *Los Angeles Times* of July 9 had an article by Senator Thomas Kearns on the cause of slides in the Panama Canal, which I read with a great deal of interest. I also have had considerable experience with swelling ground, during my thirty odd years of mining; and I am still having it; but with all due respect to the Senator's superior geological knowledge and greater experience, I cannot agree with him.

If the slides are caused by "gas pressure," as he believes, then why doesn't the pressure cease when the ground has cracked loose, making fissures through which the gas could escape?

It is my experience that the swelling element is contained in the material itself, whether solid rock or crushed material or gouge (the latter being a mud, hard or soft).

The mines along the Mother Lode here in California, pretty much all have trouble with swelling ground, and it generally occurs in the gangue and in either wall for varying distances. In some places the area of swelling is narrow enough to be entirely removed by the width of the drift or slope, in which case the swelling continues only from above and below. I have always thought the main cause of swelling was lime, which slakes when exposed to air, or air and water. I cannot accept the Senator's elaborate test of his swelling material as conclusive, since I believe his process of kiln-drying and roasting permitted it to exhaust its swelling qualities, or to destroy it. Had he taken the raw material and placed it in a glass receptacle and added

water, or even let it remain exposed to the air, he would have noted a continuation of the swelling.

A good example of what swelling material will do, after having been removed from any possible gas-pressure, may be seen in Anador county, where the old dump at the Hardenburg mine crawled or moved on an incline of less than 30 degrees, and did so for months after any fresh material had been added to it. But granting the Senator's theory to be correct, then how is the ground at the Canal to be relieved of its gas-pressure?

The experience of sinking shafts and working in swelling ground is not of an optimistic nature. Boring would be useless, since the holes would close almost immediately on completion, unless properly cased, which would nullify their value. Personally, I believe, as do the Canal engineers, that the slides are caused by the weight of the banks on the soft underlying material, with a possible swelling tendency, and when this ground breaks loose and moves, it pushes the soft material ahead of it and causes it to bulge in places. A good example of this may be seen on the line of the Southern Pacific railway between Benicia and Sacramento, where the road passes through some marshy country. When the road-bed was being built the rock-ballast squashed the mud out of place, and raised it in ridges on either side of the track, in some places higher than the road-bed itself.

It is my belief that the only thing that can be done at the Canal is being done, namely, remove the material until the banks have attained an 'angle of repose.' A thorough ditching of the banks to carry off the torrential rain-water should be beneficial. This would permit the banks of the Canal, composed of this rotten porous material, to drain itself and stiffen.

The above is not in the spirit of criticizing the learned Senator. We all wish to see the Canal a success, and it will be.

F. J. MARTIN.

Angels Camp, July 15.

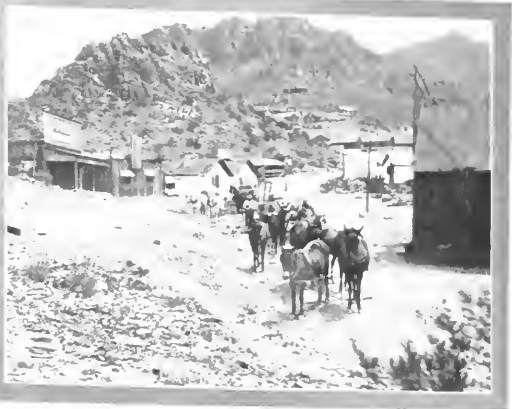
[We have received copies of several newspapers containing the Senator's article. If we remember correctly, he propounded his explanation on the opinion of a mining engineer in his employ, not on his own. In any case, it did not seem convincing, in the light of information obtained from other observers. We discussed the subject of the slides, and the cause of them, in our issue of June 10.—EDITOR.]

CHINA is reported to have exported 13,000 tons of copper coins to Japan in 1915, and dealers in Shantung province are said to have accumulated 20,000 tons more, a total of 33,000 tons, which is nearly as much as the annual output of copper by the Calumet & Hecla company, and nearly half the normal yearly production of copper in Japan.

SALT production of the United States in 1915 was 38,231,496 bbl., averaging 31c. per bbl., equal to \$2.19 per ton, a general increase.



THE MAIN STREET.



HAULING CONCENTRATES.

The Oatman District, Arizona

By Leroy A. Palmer

GENERAL. This district, commonly known as the Gold Road-Tom Reed, and officially as the San Francisco mining district, is situated in the western part of Mohave county, Arizona, about ten miles due east of the Colorado river at the point where California, Nevada, and Arizona come together. It is 27 miles by stage from Kingman, Arizona, and 20 miles from Needles, California, both on the main line of the Santa Fe railroad. The district is on the west flank of the Black range, which separates the Sacramento and Mohave valleys. Drainage from the west slope is directly to the Colorado river.

The Black range is typical of the desert. Elevations in this vicinity are not extreme, the town of Oatman having an altitude of 2500 ft., and most of the slopes are moderate, in comparison with the rugged topography of the Rocky mountains and the Sierra Nevada. Occasionally a fault-scarp or some other geologic feature, as the outcrop of an erosion-resisting dike or vein, gives local abruptness to the hills, but, in general, the slopes are such as can easily be scaled.

Climate and vegetation are characteristic of the southwestern desert. The winters are moderately cool with occasional short periods when the thermometer falls well below the freezing-point. The summers are blazing hot, the mercury soaring to 115° and above, but the humidity is low; there is a daily breeze and the nights are pleasantly cool.

The precipitation is scanty, about five inches per annum in the valleys and somewhat more in the mountains. The vegetation is typical of the arid regions of the South-west; greasewood, various cacti, including the giant *ocotilla*, sage-brush, yucca, this last being the

only growth in the locality that is suitable for fuel.

HISTORY. The first discovery in the district was made in the early 'sixties by a party of Californian prospectors headed by John Moss, who found very rich ore on what is now known as the Moss mine, about four miles north-west of the Gold Road. A rush of considerable proportions followed but conditions were rigorous, even for the hardy pioneers, and the Indians were so hostile that prospecting was unsafe except in large parties, something to which the prospector is naturally averse. But about ten years later the number of the inhabitants was augmented by many who worked their way down from Pioche and other Nevada camps so that the Indians withdrew farther into the mountains, the prospectors enlarged their field of exploration, and several new districts were discovered.

Two attempts at milling the ore were made in the early days, one by the Moss mine and one by a custom-mill, but both were unsuccessful. Consequently until the extension of the railroad in 1882 all ore was hauled or packed on burros to the Colorado river, transported by steamer to the Gulf of California and thence by ship to San Francisco, where it was transhipped to the smelters in Wales. Obviously the ore had to be rich to stand such a haul and when the higher grade deposits were worked out operations in the district slackened and the miners scattered, many of them going to the silver discoveries that had been made to the east in the Cerbat range.

The district experienced a revival in 1902. Tom Jones, a Mexican prospector who had been a "blabster" by Henry Lovin of Kingman, and one of the leading ones of Oatman, discovered the Gold Road mine with quartz

ing a stray burro. The mine was sold shortly after by Jeneres and Lovin, eventually becoming the property of a French syndicate, which sold it to the United States Smelting, Refining & Mining Co. in 1910.

The Blue Ridge, now the Tom Reed, was discovered two years earlier than the Gold Road, but active operations were not commenced on it until after 1906, when it was sold to the Tom Reed Gold Mines Co. composed chiefly of Pasadena capitalists.

Both of these mines became producers and soon thereafter dividend-payers. Their success stimulated prospecting, several claims were located in the district, and a few of them became productive in a small way. But the real awakening, in the spring of 1915, is due to the United Eastern.

The Tom Reed, which was working through the Tom Reed shaft, toward the south-east end of its ground, went about half a mile to the north-west and sunk a shaft on its Olla Oatman claim. A cross-cut was started from the shaft, but found no vein where it was expected. This fact became known to George W. Long and J. L. McIvor, two practical miners with a good working knowledge of geology. They formed a theory as to the whereabouts of the missing vein, and, while working underground in the Tom Reed, made such observations as confirmed them in their belief. They then bought from J. F. McConnell and Joe Perrizzo the ground on which they believed the vein was to be found, financed it for limited development work, and commenced sinking a shaft in September 1914. At 200 ft. they cut the vein and at 300 ft. they drove a cross-cut, which, in February 1915, broke into the vein where it had a width of 30 ft. and assayed up to \$190 per ton. Naturally this awakened interest in the district and attracted the attention of men of reputation and capital, so that a year later claims were located over an area of 120 square miles. There has probably never been a new district in which so much cash was paid into the treasuries for actual development work and so many competent mining men were in charge of operations as at Oatman. At this time there are approximately 125 companies operating all told, and about 4000 people scattered through the five towns in the district.

GEOLOGY. On casual examination, the geology of the district appears to be comparatively simple, but, as one goes into it, complexities appear and it resolves itself into a problem presenting many angles. For the following general outline I can claim nothing strictly original. It is rather the correlation of the notes of several engineers who have given the subject considerable study, checked and supplemented to some extent by my own observations in the field.

Briefly, the formation is as follows: A pre-Cambrian complex, which forms the base of the range, and consists of schist, granite, and gneiss, appears locally as granite-gneiss in limited areas, notably in the vicinity of Boundary Cone peak. Overlying this basement complex is the Tonto group of sharply upturned Paleozoic sediments. These are also of very limited extent, locally

only one outcrop giving a favorable exposure, at a place $3\frac{1}{2}$ miles west of the town of Oatman and a quarter of a mile south of the Times claim, where this group appears as limestone, almost invariably marbled, and as metamorphosed shale.

Overlying the sediments are various flows of presumably Tertiary age. The most important of these rocks is andesite, of which four distinct flows have been recognized. Locally the andesite is labeled as the 'earlier' and the 'later.' The 'earlier' is a typical andesite that rests on the Tonto group, or, where these sedimentaries have been removed by erosion, directly on the pre-Cambrian complex. Following this extrusion came a long erosion interval preceding the outpourings of 'later' andesite. Four different flows, one of which is chloritic, without any erosion-interval, have been distinguished in the later andesite, which is of somewhat greater extent areally than the older.

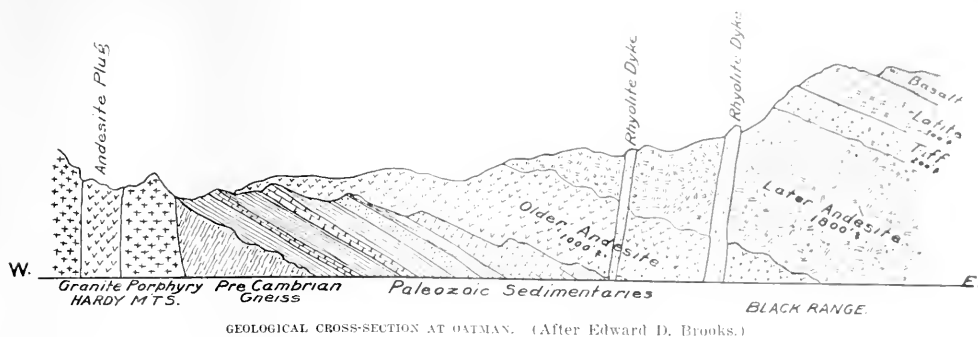
The later andesite was covered by a layer of andesite tuff, overlaid by latite, and that, in turn, by an amygdaloidal basalt. The latite and basalt do not appear in the immediate vicinity of Oatman, but the ridges thereabouts are capped by the later andesite, which exhibits the pronounced columnar structure usually found most highly developed in the basalts, so that one observing these ridges from a distance would come to the natural conclusion that he was looking at the latest of the flows.

VEIN FORMATION. All of these flows, except the latite and the basalt, were subjected to heavy stresses resulting in a series of profound fault-fissures, which were subsequently intruded with dikes and plugs of rhyolite. These fissures have a general northwest-southeast strike but north-west of the town, in the vicinity of the Pittsburg and Times, is a series with almost due east and west strike. These have generally been supposed to represent a distinct system but more recent observations in connection with development work tend to the conclusion that they are all part of one great fissure system.

The age of all of the volcanics is supposed to be Tertiary. The andesites were Early, the period of faulting and intrusion Middle, and the latite and basalt Late Tertiary, with the possibility of the basalt overlapping into the Quaternary.

Following the intrusion of the rhyolite, veins were formed along the dikes and adjacent thereto, and in a few instances, as at the Gold Road, in the dikes themselves. These veins are of calcite and were probably formed by hydro-thermal action on the feldspar of the andesite, this action being accompanied by a silicification of the andesite in the immediate vicinity of the veins. The andesite when silicified much resembles quartzite and, resisting erosion to a greater extent than the unaffected rock, stands up in many prominent ridges or combs by which the veins can sometimes be traced and which have given rise to a local term, 'quartzite dikes.'

The calcite proper is barren, but following its deposition the veins were strike-faulted, thus allowing the upward circulation of silicious solutions containing gold, which was deposited by metasomatic replacement of the



calcite. The veins show distinctly the banded structure characteristic of deposition from upward circulating solutions, and specimens of quartz pseudomorphic after calcite are not rare. Occasional specimens are found in which the gold appears to be deposited in the calcite itself, but it is probable that the microscope would show that it is associated with some quartz. As a rule the walls carry very little gouge, but they are usually clean-cut and the veins are rarely found frozen.

Thus we have two periods of faulting previous to mineralization and having a direct bearing upon it. There was also a third period, which was subsequent to mineralization. Following the deposition of the gold ores intense lateral stresses brought about a series of transverse faults at right angles to the major faults, in which the throw was largely horizontal and limited to a few hundred feet. This resulted in a displacement of the veins, but had no mineralizing effect, as evidenced by the fact that the transverse faults are barren except for

such small amounts of mineral as have been carried onto the fault-plane by the drag.

So far, all of the orebodies are in what may be designated for the occasion as the 'middle' andesite, that is, the uppermost of the flows as well as the earlier andesite are barren although the veins are found therein. For some time it was supposed that the ore-zone was delimited by the chloritic andesite, but more recent developments have upset this theory, although the occurrence of any ore-shoots in the earlier andesite is yet to be demonstrated. There is no doubt that the veins extend into the pre-Cambrian and some ore of value has been found therein, but at present it is not safe to say what part this formation will play in the future of the district.

The fact that it is customary in the Oatman district to sink to depths of 300 to 500 ft. before attempting to reach the vein has given rise to the general belief that pay-ore is not to be found nearer the surface. This con-



TOWN OF OATMAN AND PART OF THE GOLD ROAD

ception is not strictly true, as proved by such mines as the Times and the Oatman United, at which good ore is found on the surface. This was also the case with the Green Quartz, whose former owner, the prospector who located the ground, kept himself in bacon and beans for several years before selling to the present company by treating in an arrastra such ore as he took out by gophering around by hand, none of his workings being over 50 ft. deep. The ore occurs in shoots that are distributed both vertically and horizontally. Where the latest of the andesite flows, in which the veins are barren, are in place it becomes necessary to reach the orebodies by sinking, but where these flows have been removed by erosion and the productive andesite is exposed, there is the possibility of finding an ore-shoot at the surface.

Another reason for the deep mining at the start is that Oatman must of necessity, because of the low grade of its ores, be a deep-mine camp. For this reason the operators have recognized, fortunately, that their first task must be to prove their mines. For a new camp and one that has attracted so much attention with the corresponding temptation to speculation, Oatman, is remarkable for its conservative development and the lack of elaborate or unnecessary equipment.

The veins of the district can be classified into four different mineral zones, according to the more prominent mines thereon. These zones tend to show a slight convergence toward the south-east, but the junction, if there is one, has not been found, being concealed by the later flows and surficial material.

The veins of the district have been traced over distances of several miles. Their general appearance indicates depth, but as yet a definite prediction as to the persistence of ore cannot be made. As stated, no orebodies of importance have yet been found in the earlier andesite, but development in this zone is very limited. The ground-water level presumably coincides with that of the Colorado river, which has an approximate elevation of 5000 ft., 2000 ft. lower than the town of Oatman. Thus if the ore persists to that depth it will be found oxidized to the level of the river. If this proves to be the case, it will not be necessary to make any material change in milling practice for some years to come.

This account is necessarily brief, for the reason that scientific evidence concerning the geology of the district is still so incomplete, a condition that development is tending to overcome. There are many problems yet to be solved; for instance, as to whether the east-west fissures in the vicinity of the Times are distinct or part of the main fissure system. Do the fissures unite somewhere south-east of the district, and, if so, what is the result? Why are ore-shoots limited to the 'middle' andesite, while the 'earlier' and the upper flows are barren? There have been some interesting theories formed on some of these points and I should like to go into them, but that is properly the privilege of those who are working them out and who will undoubtedly be able to make more definite statements later than I could offer now. Oatman promises to be a fruitful field for the geologist as well as the miner.

The New Anaconda

In a pamphlet entitled 'The New Anaconda,' Eugene Meyer, Jr., & Co. of New York describe present conditions at that great property. The pamphlet says in part: Anaconda is mining, reducing, and marketing at the rate of 330,000,000 lb. of copper annually—approximately one-fourth of the copper produced in the United States, and one-seventh of the copper produced in the world; in addition, it is refining and selling the product of other companies, in some of which it has part ownership, to the extent of 240,000,000 lb.; making a grand total of 570,000,000 lb. of copper—more than one-third of the product of the United States and nearly one-fourth of the total copper production of the world. Anaconda, besides its copper, is producing annually 13,000,000 oz. of silver and 150,000 oz. of gold; is smelting and refining at its custom-plants an additional 4,000,000 oz. of silver and 100,000,000 lb. of lead; it will, within a few months, be producing at the rate of 70,000,000 lb. of zinc per annum. By the end of 1916, Anaconda will be using 126,000 hp., or 700,000,000 kilowatt-hours annually. Electrification has meant a saving of \$3,500,000 to \$4,000,000 annually. Prior to 1915 Anaconda found it impracticable to separate more than 82% of the copper in the ore. With flotation machines installed, the recovery of copper in concentrate has been increased to 96%. The leaching-plant, in which tailings are treated, has a capacity of more than 2000 tons per day and recovers about 85% of the metal in the tailing. Its annual recovery amounts to 7,000,000 lb. of copper at a cost of 8½ cents per pound. As the old tailing piles contain more than 20,000,000 tons, there is enough of this material available to enable the leaching-plant to continue at the present rate for nearly 30 years. These tailing piles are capable of being converted into 200,000,000 lb. of copper. It is a conservative assumption that Anaconda in 1917, with normal prices of zinc, will be able to earn a profit of two cents per pound on its 70,000,000-lb. output—an annual net earning of \$1,400,000 from this new source.

Earnings in Montana:

300,000,000 lb. copper annually at cost of 9c. per pound, copper at 14c.	\$15,000,000
70,000,000 lb. of zinc annually at a cost of 3½c. per pound, zinc at 5½c.	1,400,000
	<hr/> \$16,400,000
Other income:	
Return from security holdings	6,250,000

Total	\$22,650,000
Per share	\$9.72

Within the next few years the company should begin to realize on its investment in Chile. It is fair to assume a production of 100,000,000 to 150,000,000 lb. of copper annually at a profit around 5 cents per pound under normal metal prices. Anaconda owns 75% of the operating company in control of the Chilean deposits. This should return an amount equivalent to at least \$2 per share per annum on Anaconda's stock.

Ore Treatment at the West End, Tonopah

By Jay A. Carpenter

A considerable amount of interesting work has been done at the West End mill, as the following notes from the annual report for the past year will show:

There was 56,976 tons treated, with a gross value of \$958,657.

The value is calculated at \$20.67 per ounce for gold, and 50.35 cents for silver. The average metallic content of the ore was 0.245 oz. of gold and 23.42 oz. of silver. Gold extraction of 94.80% and silver of 90.88% are the highest recoveries yet made by the West End mill. The combined extraction was 90.92% of the metallic content, and 92.10% of the money value of the ore. (This latter figure of 92.1% is the accepted method of reporting extraction.) It is to be further noted that this recovery was made by cyaniding only. Concentration was abandoned in 1914, as the additional gross extraction made by its aid was overbalanced by the 8 to 10% marketing cost on the value removed in the concentrate. The cost in 1915 of marketing the products of cyanidation was only 1.7% of the gross value of the ore, giving the high net extraction of 90.4%. This is also the highest annual figure yet attained, and is considerably above the average 1915 figure of 89.75% for the mills of the Tonopah district.

The total recovery of metals was 13,219 oz. of gold and 1,210,037 oz. of silver.

The daily amount treated was 156 tons, which required 22.6 stamps dropping continuously, giving an average of 6.9 tons per stamp-day. Of the daily tonnage, 39 was custom ore, and 47 was the disputed Jim Butler v. West End ore which was treated as custom. The custom ore was irregular in quantity, varying from 86 to \$96 per ton, and ranged in character from oxidized-ore screenings to the hard flint of the Kernick ore. These variations made it impossible to keep the consumption of chemicals and power to as low a point as could be done with a fairly consistent tonnage and grade of ore, and it required great attention to details of plant operation to obtain equal extraction. The sampling of all ores, with the control assays and necessary supervision, introduced a new expense in milling charges. However, if the treating of custom ores added to the expense of milling, it was far over-balanced by the direct profit from the milling of these ores. In addition to the direct profit there was an important indirect profit accruing from the increased daily tonnage milled.

During the last six months of the year the average value of the ore treated was \$20.10. This was a composite of Tonopah ores, being mainly sulphide ores. A gross extraction of 92.1% was obtained, giving a net extraction of 90.5%. Although there was no concentration, the average titration of the strongest solution in the

mill, being that of No. 1 agitator, was 3.5 lb. of potassium cyanide and 0.7 lb. of protective sodium cyanide. Sodium cyanide consumption was 2.9 lb. and 1 lb. of zinc shavings. These results are worthy of mention, as they mark a high point in the treatment of Tonopah ores without concentration.

The year 1915 was notable for its advance in price of nearly all materials used in milling, but such increases are usually met in all industries by greater economy and a closer study of costs. We are pleased to state that in our case, with a reduction in daily tonnage from 179 tons to 156, and with an increase in the gold and silver contents of the ore from 18.7 to 23.66 oz., the total direct milling costs show a decrease of 3c. per ton. With the decreased tonnage the total cost of labor and power per ton was held at the same figure, and with a 25% increase in the metallic content of the ore the cost of supplies actually decreased 3c. per ton.

The following table shows the main items of cost for 1915, and those of 1914 for comparison:

	Amount Used per Ton		Cost per Ton	
	1915	1914	1915	1914
Labor (average of \$4.50 per shift), shift	0.156	0.161	\$0.704	\$0.724
Power, kw.-hour	36.0	35.6	0.526	0.506
Sodium cyanide, pounds.....	2.6	2.83	0.567	0.600
Cut sheet zinc, pounds.....	1.21	1.34	0.179	0.126
Lime, pounds	3.88	3.95	0.028	0.032
Lead acetate, pounds.....	0.66	0.43	0.074	0.07
Fuel-oil, gallons	3.19	3.19	0.322	0.321
Water, gallons	226.0	216.0	0.71	0.85
Pebbles, pounds	7.39	6.05	0.07	0.05
Tube-mill liners and supplies.....			0.06	0.058
Shoes and dies			0.00	0.00
Other supplies			0.07	0.07
Total direct milling costs.....			\$2.74	\$2.768
Indirect costs without depreciation			0.21	0.202

Total direct and indirect without depreciation, \$2.95, \$2.970

Special features that held the interest of the miller during 1915 were as under:

Six tons of manganoid steel balls were substituted for the six-ton load of Danish pebbles in the 5 ft. 15 in. tube mill. There was a sharp increase in the power required for the mill, but less power per ton ground. The saving in power was over-balanced by the greater cost per ton for the steel balls. Later, the mill was reduced to 3 ft. 5 in. diam. and charged with steel balls, resulting in a considerable increase of tonnage, and decrease in the power required for the mill, and the cost of Danish pebbles for the 5 ft. mill. On account of the saving in power per ton ground, the test is being continued with a 2 per cent to determine the consumption of steel balls. Under the

favorable conditions of the 3-ft. diam. mill. In 1915, using mostly Manhattan, Nevada, chaledony pebbles in the 5 by 18-ft. tube-mills, the consumption per ton of ore was 20% greater, but the total cost per ton of ore ground was 20% less than in 1914 when Danish pebbles were mostly used. The Komata shell-liner placed in one of the 5 by 18-ft. mills in 1913, with the idea of reducing the cost of shell-liners 50%, has given the following results: life of plates, 22 months; life of angles, 6 months; while filler-bars were not worn at all. All this material was purchased from the local foundry, and the cost per ton ground was 2c., which is 33% of the cost when using the smooth liners.

In order to hasten the settling of light slime that lies close to the surface of the Dorr thickeners, an experiment was tried in one thickener of placing $\frac{1}{2}$ -in. square sticks 4 in. apart horizontally, and projecting 3 ft. vertically below the surface of the solution-level. Due to the daily change in character of the ore milled, accurate settling data have not yet been obtained, but the originator of the idea demonstrated a great improvement in settling in his experimental tank thus equipped.

During the year one of the Trent agitators was equipped as a replacer, to determine the feasibility of replacing the rich solutions of the agitator pulp with barren solution and then with water without recourse to the canvas leaf-filter. It was shown that it was possible to maintain a barren zone in the bottom of the replacer and thus replace solutions by this method; but, like the continuous-decantation system, although to a lesser degree, the extra tankage required did not justify a change from the present leaf-filter.

The most interesting and profitable experimental work of the year was a study of the mill solutions to determine what saving could be made in the use of cyanide and zinc without lowering extraction.* The result was an increased extraction, as shown in the figures given above for the last six months of the year. The saving in chemicals is shown by the fact that during 1915 we used 0.126 lb. of sodium cyanide per fine ounce of gold and silver bullion, compared with 0.170 lb. in 1914, a saving of 26%; and in 1915 we used 0.056 lb. of zinc shavings per ounce of bullion, compared with 0.081 lb. in 1914, a saving of 31%. While the 1914 results compared favorably with standard practice of this district, the 1915 consumption of cyanide and zinc would have been about \$16,000 greater had the 1914 consumption figures prevailed. This would have increased milling costs 28.1c. per ton.

During the year considerable testing was carried on to find out if the flotation process could be used instead of cyaniding on West End ore, or as an adjunct to cyaniding. Although flotation can make an equal extraction with cyaniding on sulphide ores, it was decided that there was no field for flotation at present in the mill, as some of the ore is oxidized, and there is at present no satisfactory method of treating silver concentrate locally.

It is to the credit of the mill-crew that, due to their

observance of Safety-First the year passed with only minor injuries, and no call was made on the State insurance fund.

Gold in Bolivia

A gold nugget weighing 14 lb. was recently found in the placer mines of Benedicto Goytia at Chuquiguillo. This nugget has a maximum diameter of 13 centimetres (1 centimetre = $\frac{1}{2}$ in.) and a maximum and minimum thickness of 8 and 3 centimetres, respectively; it is valued at \$4,000. In the gravel of this same river another celebrated gold nugget, worth \$4500, was found by an Indian miner in the seventeenth century, and was placed on exhibition in the Museum of Natural History at Madrid, Spain. Much of the gold in the possession of the Incas at the time of the invasion of the Spaniards 384 years ago is said to have been obtained from the Chuquiapu and Chuquiguillo rivers. The name of the latter river means in the Aimara Indian language 'inheritance of gold.' In Bolivia gold is widely distributed in veins and placers. Along the rivers which run in a north-easterly direction following the eastern slopes of the Andes, there are extensive deposits of auriferous sands of great richness. The Chuquiapu, or river of gold, upon which La Paz, the capital of Bolivia, is situated, contains within the city limits auriferous gravel washed down from the slopes of the Andean range, and during the colonial period the gold-placer deposits of this river in the vicinity of La Paz were profitably exploited by the Spaniards.—*Bulletin of Pan American Union*.

Chromite

The only commercially important ore of chromium is chromite, which is an oxide of chromium and iron, FeCr_2O_4 . In California the iron is likely to be replaced by magnesium, and the ore is found in serpentine. Chromite is usually sold on the basis of 50% of chromic oxide ('chromic acid'), Cr_2O_3 , on which basis it brings \$12 to \$30 per ton at New York. The wide variation in price is due to the irregular and uncertain condition of the market, which is affected spasmodically by imports.

The production of chromite in the United States during 1915 was 3281 long tons. The quantity imported was 76,455 tons; this came from New Caledonia, Rhodesia, Portuguese Africa, Quebec, and Greece. The domestic production is largely from California, which uses most of its output locally, although a little is shipped to the Eastern States at a freight rate of \$11 per ton. The Quebec deposits have attracted attention since a revival of mining during the past two years. During 1915, Quebec shipped 10,087 tons of chromite to American buyers in Pennsylvania steel districts. New Caledonia, the French island in the South Pacific between Australia and Fiji, has been the world's greatest producer of chromite, having mined as much as 82,806 metric tons in one year. Of late years Rhodesia has been an important producer.

* M. & S. P. Dec. 11, 1915.

An Improved Pneumatic Flotation Machine

By James M. Hyde

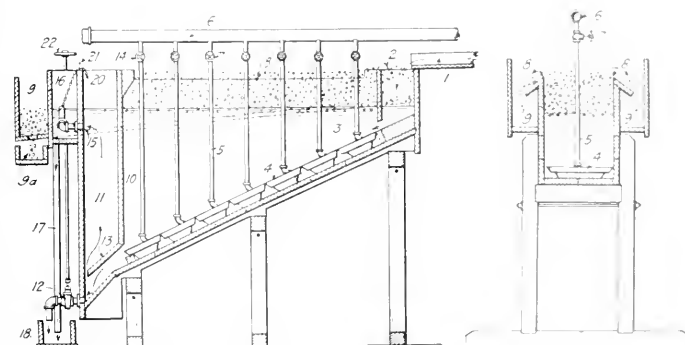
Having had occasion to introduce concentration by flotation into a mill where the flotation machine would have to be in charge of the table-operator, whose time was already fully occupied with his regular work, it was necessary to design an apparatus that would give a maximum recovery with a minimum of attention.

In order to meet this contingency, a machine was designed containing sundry novel features. Details are shown in the accompanying drawings. The body of the machine is a rectangular tank with a sloping bottom and overflow sides. Pulp from the launder (1) enters the feed-chamber (2) and flows into the flotation-chamber, where it passes over the cast-iron air-cells (4), through the upper canvas surface of which compressed air is being forced. The air is supplied through the hose (5) from the header-pipe (6). Each air-cell is regulated independently by a valve (7). The air rising through the previously oiled pulp builds up a bed of mineral-bearing froth above the water-level; this froth flows continuously over the lip (8) and is carried away by the launder (9) and the cross-launder (9a). The bed of fragile froth, which readily breaks down unless air is constantly bubbling up beneath it, is prevented from flowing over the tailing-discharge, where no air is rising, by a partition (10) that divides a dead-water space (11) from the frothing-chamber. The bulk of the tailing is discharged through the valve (12). The deflector (13) guides any bubbles carried toward the tailing-valve by the flow of the pulp back into the frothing-chamber. The deflector (14) causes a counter-current of froth to flow toward the feed-end of the machine. Slime-tailing flows through the opening (15) and the swing-pipe (16) and through the drain-pipe (17) and joins the sand-tailing in the main tailing-launder (18). The swing-pipe (16) may be fastened at any desired height by engaging the proper link of the chain (20) over the nail (21). When the valve (12) is set by the handle (22) so that the valve does not permit quite all of the tailing to flow through it, the position of the swing-pipe fixes the height of the water-level, which will not vary until the pipe is re-set. The novel features of this machine are:

(1) Individual Air-Cells. This feature is of prime importance. There is no possibility of leaky partitions

permitting air from one cell to leak into and be discharged from another. A perfect distribution and control of air is therefore possible. The air-cells may be kept on hand ready to be put into the machine and if a leak comes in the canvas in any part of the machine, the leaky cell may be replaced in less than five minutes and the canvas changed at leisure. Thus better work and more continuous service is ensured than would be the case if the whole canvas had to be changed at once.

(2) No Froth Over Tailing-Discharge. This ensures a maximum recovery. The 'mineral' in the froth that breaks down over the tailing-pocket is lost, as no air is rising there to re-float it.



Longitudinal Section

Cross Section

SECTION OF THE FLOTATION MACHINE

3 Counter-Current of Froth Toward Feed End. This also assists in attaining a high recovery by making all of the froth that rises at the tailing end of the machine flow quickly away from the danger zone.

4 Constant Water Level at any Desired Height. By setting the sand-tailing valve so that not quite all of the tailing is discharged through it, and then setting the swing pipe at any desired point, all fluctuations in flow are positively taken out of and the water level remains at the determined point. The final water level is always visible to the operator from the dead-water compartment.

5 Amount of Attention Required. The test of this machine is tested as in any other machine also used for three Chulavilla mills and 2240 Wells tables. The constant water level device and the improved position of the tailing, which is easily adjusted, account for the fact that the machine requires so little attention.

The machine has a capacity of 100 tons per day.

treating pulps that are much more dilute than it has been considered possible to treat satisfactorily, but dilution of the slime-pulp should be avoided as far as possible by de-sliming with a minimum amount of water after each crushing operation before thorough classification, jigging, or tabling is attempted. By following this plan the bulk of the classification water, and the jig and table water, can be kept out of the slime or flotation-feed.

The oil-feeder, which has been used so satisfactorily with this machine is of the type used by the Anaconda company and was all ready to install when the description of the Anaconda feeder appeared in the *MINING AND SCIENTIFIC PRESS*. It consists of a revolving disc on which are mounted cups that raise the oil from a pan and discharge it into a tray, from which it flows to the ore-pulp, and mechanism for driving the disc with a variable speed. This feeder is much more positive than any form of valve, is less trouble than any kind of a pump, it can be regulated and set to give any desired amount of oil, and will continue to feed exactly that amount. The feeder shown in the photograph is made up from parts that are standard and with accessories that can be obtained or manufactured anywhere.

Referring to the photograph, (1) is a worm-gear speed-reducer, such as is used in window-display work. This is regularly provided with a cone-pulley, but as it was necessary to actuate the oil-feeder from a line-shaft running at 240 r.p.m., a wooden pulley was fitted over the cone-pulley, so that a flat belt could be used. The speed-reducer has a ratio of 48:1. The wooden disc (3) was fitted to a plate regularly attached to the speed-reducer. A buffing-head (4), to one end of the spindle of which a wooden disc (3a) had been fitted, was so set that the discs (3) (3a) were off-centre. Motion is transferred from (3) to (3a) by a leather-faced wheel that runs freely between fixed collars on the round rod (6), one end of which is threaded so that the position of the wheel (5) may be varied. A yoke support (7) threaded at one end, supports the rod (6), which has a hand-wheel at one end and a lock-wheel at the other. A circular disc (9) is attached to the spindle of the buffing-head. To the face of this plate four 32-calibre cartridge-shells were attached by flat band-spring standards. It is necessary to set the cups out from the plate so they will drip freely into the drip-tray, not shown in the photograph. Any number of cups may be used. The spring (10) ensures contact between the driving disks (3) (3a) and the wheel (5).

This arrangement gives absolute control of the oil-feed. Many variations of it will suggest themselves, but this one has proved satisfactory and is made of standard parts easily obtainable. If many were to be made, the plates (3) (3a) could be made of cast iron and the stand of the speed reducer could be made as high as the stand of the buffing-head.

It has been found that satisfactory oiling is obtained by adding the oil to the pulp before it goes to an elevator to be raised to the level of the flotation-machines. I have found that a launder in which square blocks of one-third

to one-half the width of the launder are placed alternately along the sides makes an efficient mixer, or any kind of a vertical or inclined cascading device is serviceable. The launder with hindered flow is excellent, it uses a minimum of head-room, and requires no power.

The details of the method of dressing the individual air-cells are shown in the accompanying photograph, which makes plain the method of attaching the canvas with a wooden parting-stop, and of obtaining a flat surface by covering the canvas with wire hardware-cloth. The strip across the centre is punched-screen and may be omitted.

It has become customary in introducing flotation machines to the mining public to present genealogy in order to establish their respectability. The following family tree is presented for the improved machine herein described.

The first successful commercial application of flotation concentration on a large scale was the use of the Potter and Delprat processes in the treatment of Broken Hill zinc-middling. In this work hot acid solutions reacting upon the calcite of the ores generated carbon dioxide gas, which, with the assistance of no other oil than that in the exhaust-steam by which the solution was heated, caused the zinc sulphide to rise and overflow as a froth. Potter used several devices in his work, the final one being a pointed lead-lined tank. Delprat's patent shows a tank with a bottom sloping from the feed-end to the tailing-pocket and provided with an overflow for the removal of the mineral-bearing froth at the water-level.

At about the same time, Alcide Froment, in experimenting with the Elmore bulk-oil process, observed the effectiveness of gas bubbles in floating slightly oiled particles. Three students of the University of California also independently observed the same phenomena and described the agitation-froth process in the California Journal of Technology for November 1903.

In 1903 Sulman and Picard broadly described the method of floating certain minerals as a froth by introducing a gas into an oiled pulp in a patent in which one form of apparatus suitable for carrying on their process was described and figured as a tank in which revolved a coiled pipe through the perforations of which air was introduced into the pulp with aspirated oil. The coil was to be revolved so as to cut the air into small bubbles and mix it with the pulp. The tank had a sloping bottom and received the pulp at one end, discharging the tailing at the opposite end, with an overflow for the mineral froth.

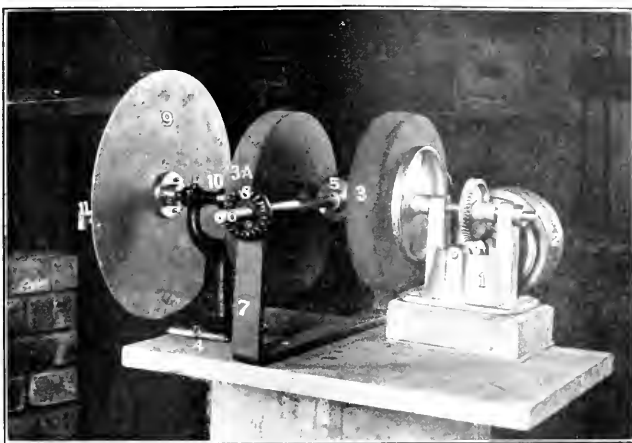
In 1910 Theodore J. Hoover and Minerals Separation Ltd. took out a patent in Great Britain, but not in the United States, in which was described a process for introducing gas into an oiled pulp through a permeable medium with the object of causing floatable minerals to rise and be separated from the rest of the ore.

In this patent various permeable media, such as coke, porous ceramic materials, and fabrics were set forth as fit materials through which to introduce the gas into the pulp. A number of types of apparatus were suggested.

In 1912, or thereabouts, Callow introduced into use in the United States an apparatus for causing the flotation of oiled minerals by the use of air introduced through canvas. His machine consisted of a rectangular tank having a sloping canvas bottom from beneath which air was introduced into an oiled pulp. The tank received the oiled pulp at one end, discharged the tailing from the opposite end, and overflowed the oiled mineral as a froth over the sides of the tank.

The machine described herein may be considered the section, the bottom slopes to provide for the flow of a pulp containing sand, the pulp is fed in at one end, the tailing is discharged from the opposite end, and an overflow lip is provided for collecting mineral particles buoyed to the top by bubbles. The individual characteristics that it possesses have been previously described and have been evolved to make the machine effective and easy to operate.

The machine described herein may be considered the

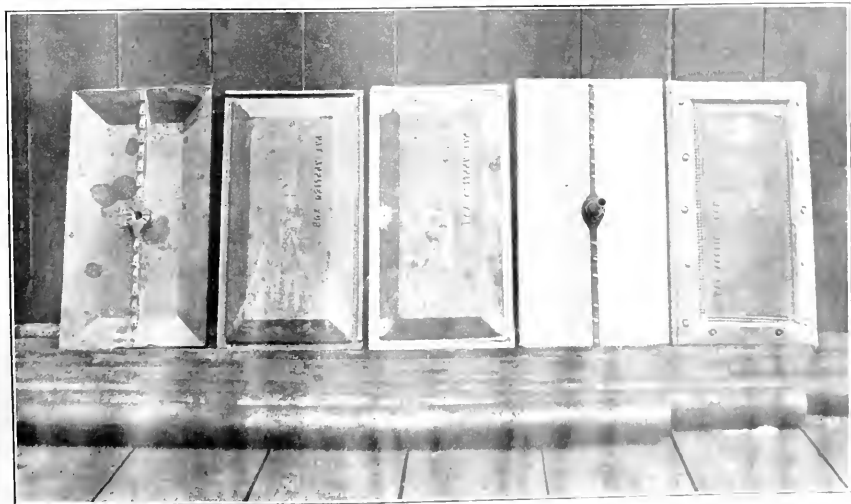


THE HYDE FLOTATION MACHINE.

lineal descendant of the Delprat and Sulman & Picard devices, the suggestions contained in the Hoover-Minerals Separation patent and the Callow machine. As in the others, the containing tank is rectangular in cross-

SOUTH AMERICAN TARIFFS have always been difficult for North American shippers to understand. It is truly said that the greatest obstacle to trade between nations is a complicated and varying tariff system. Yet import duties are the principal source of revenue for many governments. In South American countries, when money is wanted for a new project, what is called a sur-tax is added to the regular tariffs. The sur-taxes are kept separate from the regular duties, which have likely been assigned to foreign holders of government securities. Other vexatious imposts on imports include fines for failing to observe formalities, or for inexact statements in the invoices; many of these violations by shippers are unintentional. New tariff laws have been suggested for the South American countries, and have been adopted in several of them, notably

Chile. The Department of Commerce of the United States has published a report that explains in detail the tariffs of the South American countries, having been made by visiting the countries in question.



SHOWING METHOD OF DRESSING INDIVIDUAL PIECES OF ORE.

Gold-Saving on Dredges

By Howard D. Smith

During the last ten years little change has been made, until recently, in gold-saving on dredges. Long and costly experience demonstrates that saving in the sluices must be accomplished by simple riffles, fed with quicksilver, that clear themselves.

Hungarian riffles, consisting of wooden bars protected on the top by a strip of steel, are now standard practice. Formerly riffles made of angle-iron were in general use, but these were found to give more difficulty in cleaning-up, while first cost and maintenance were higher. Prior to this, cocoa matting and expanded metal were discarded

content consequently is too uncertain to be useful. Attempts to determine the gold content of the tailing directly by following the principle of taking part of the tailing part of the time will never give conclusive results. Operators thus far have been unwilling to spend the money necessary to make a test on the principle of taking all of the tailing part of the time. The amount and velocity of material to be dealt with, as well as the inaccessible position of the end of the sluice, in some cases below water-level, explains this. Re-handling *in toto* the ground previously dredged has come about where it was

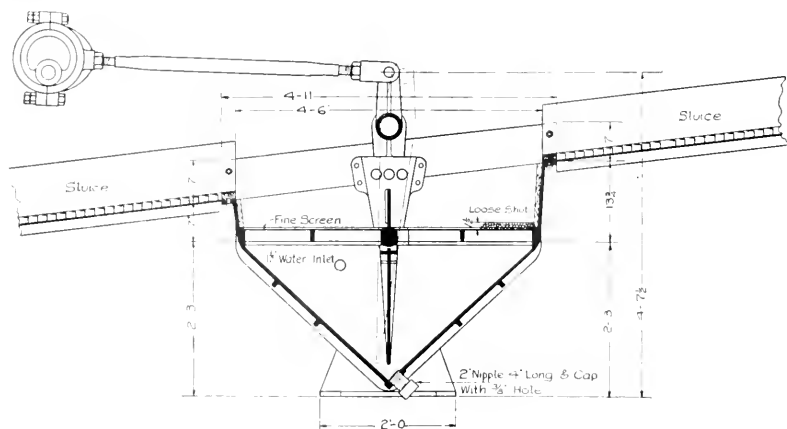


FIG. 1. NEILL JIG AND ECCENTRIC DRIVE.

in California. Owing to the scouring action of the mass of sand and water running over the sluices, amalgamating devices that expose quicksilver-coated surfaces to the action of the current have all resulted in failure, and this despite the fact that some of the devices give excellent results where small quantities of material and low current-velocities are involved. Many years ago this condition suggested the making of a concentrate that could be treated subsequently, but until recently no means at all suitable could be found.

The idea prevailing in dredging circles that gold-saving was efficient did much to prevent attempts to solve the concentrating problem. This was owing, in part, to the fact that approximately 90% of the clean-ups came from the first few feet of sluices and but little from the tail-sluices. Figures for the 'heads' are, at best, an approximation. There is only one thing definite about the occurrence of gold—lack of uniformity. Anyone who has attempted to check a rich drill-hole with others as close as a yard away becomes keenly aware of this fact. Estimation of losses by subtracting recovery from known

necessary to move a dredge through tailing-piles to reach new ground, and also by design. Very little gold was recovered by this treatment in the case of free-washing gravel where the original gold-saving was at all efficient, but considerable recovery, as much as seven or eight cents per cubic yard, was made where the ground contained clay not thoroughly disintegrated by the first washing. Obviously none of these operations determined whether more gold could be saved by other means than the standard riffles used in both treatments.

During several months in 1914 the Lyons Syndicate, in which Frank Griffin, Maurice Griffin, and O. B. Perry were interested, conducted tests at Natoma to determine whether the ideas of Robert Lyons, concerning the amalgamation of gold by the use of zinc amalgam, would prove practical on gold-dredges. The results were unsatisfactory, but, incidentally, important data concerning losses were obtained. From the results of the test on the Natoma No. 7 dredge it was estimated that when recovery from about 135,000 cubic yards by standard equipment was 23 cents per yard, approximately \$220

per day was being lost. The large loss on this dredge is explained by the clayey ground containing much rusty gold, which would not amalgamate.

Tests on No. 1 dredge, working in free-washing ground, containing no rusty gold, with a yardage approximately twice as large, and a recovery about 9c. per yard, indicated a tailing-loss of a little less than \$40 per day.

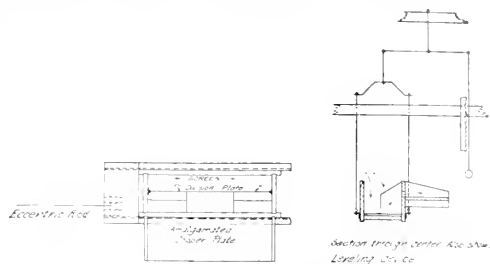


FIG. 2. SHAKING AMALGAMATOR.

The matter of selecting a concentration scheme to deal with conditions on Natoma No. 7 was then taken up. Any concentration device to be successful on a dredge must occupy small space, run efficiently with little attention, and have large capacity. The Neill jig, shown in Fig. 1, appearing to possess these characteristics, was accordingly tried. In order to brighten the gold a $4\frac{1}{2}$ -ft.

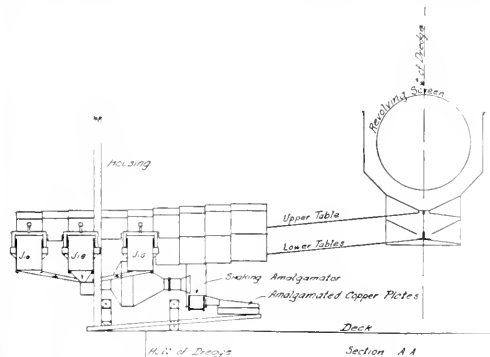


FIG. 3. CROSS-SECTION SHOWING ARRANGEMENT OF JIGS, HARDINGE MILL, AND AMALGAMATOR.

Hardinge mill, using pebbles from the tailing, was erected, followed by a shaking amalgamator and copper plates. The general scheme is shown in Fig. 2. Results are as follows:

Interval	Cu Yd.	Value per yard cents	Total recovery \$	Amalgamator recovery %	Amalgamator recovery per cent yd. of total
Dec. 20, 1915 to Jan. 27, 1916.	1,422.20	14.11	18,701.93	2129.79	1.51
Jan. 27, 1916 to Feb. 14, 1916	128.310	11.68	18,929.11	3031.67	2.55
Feb. 24, 1916 to Mar. 31, 1916	162.950	9.90	16,136.02	3290.70	1.96

The progressive improvement shown was brought about largely by better adjustment. Installation of a leveling device for the amalgamator was also beneficial.

A sizing test showed that 43% of the gold passed 100-mesh and all passed a 20-mesh screen.

Clean-ups of tail-shutes before the addition of the jigs from a point where the jigs would discharge tailing when installed to the discharge in the pond, indicated that of the gold saved by the jigs and following apparatus, from 90 to 97% would otherwise have been lost. These results were gratifying, notwithstanding their not being entirely conclusive. The gold content of the gravel was only ap-

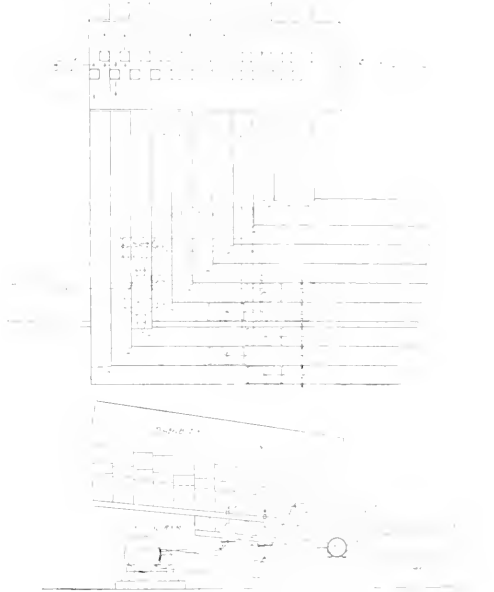


FIG. 4. PLAN AND ELEVATION OF TABLES SHOWING POSITION AND DRIVE OF JIGS AND MILL.

proximately the same throughout the comparative tests.

Under the distribution scheme on Natoma No. 7, although the amount of sand going to each side of the dredge is approximately equal, more gold is carried to the port side of the dredge, the side opposed to the rotation of the screen. Consequently, a comparative test could not be made by using rifles, only, on one side and jigs on the other. The distribution shown in Fig. 4, which is in use on Natoma No. 4, divides the gold, as well as the sand, more equally between the port and starboard sides of the dredge. For this reason it is hoped that the management will shortly make a more conclusive test on this boat. The installation on Natoma No. 10 is similar to that on Natoma No. 7. There is, however, much less rusty gold than in the case of Natoma No. 7.

Results at Natoma No. 10 are as follows:

Interval	Cu Yd.	Value per yard cents	Total recovery \$	Amalgamator recovery %	Amalgamator recovery per cent yd. of total
May 7, 1916 to June 1, 1916	291.40	1.18	343.05	1.18	0.40
June 1, 1916 to July 2, 1916	18.00	1.18	21.24	1.18	0.07

Data from the plant at Natoma No. 4, where no mill is necessary to brighten the gold, will soon be available. The results obtained in this case are more like what may be expected under average conditions, for the gravel at No. 4 is clean wash and the gold is not rusty.

The increased saving over standard riffles is due not only to the greater quantity of fine gold saved but also of finely divided quicksilver. One extra man per shift is necessary for the efficient operation of a jig plant. Special care should be taken to screen the water fed under the jig-screens so that they may not become clogged.

In order to place the jigs the most important lower tables were taken out. While this increases the load on the upper tables, the excess material is distributed over so many of the tables that the efficiency of the riffles is not impaired. It is hoped that it may prove safe to discard all the lower, and part of the upper, tables by placing the jigs in the tables instead of in the tail sluices.

The development of the jig and other gold-saving devices is due to the efforts of F. W. Griffin, L. D. Hopfield, and Edward Strouse, of the Natomas Company, together with the cordial co-operation of the general manager, Emery Oliver. The results given are not held to be representative, but are interesting, and with the extension of the jigs to other dredges, together with experiments now being carried out on the Feather river, will, in the near future, give data relative to the more general application of the jigs.

THE AMERICAN SMELTING & REFINING Co. received \$54,952,106 from sales of gold during 1915. This is equivalent to more than one-half the annual production of gold in the United States. While the A. S. & R. Co. operates smelters and mines in Mexico, the bulk of its holdings are in this country. The silver production of the company in 1915, partly of course from Mexico and Canada, was \$38,007,727, which is more than the entire annual output of silver in the United States. The company's receipts from sale of lead during 1915 was \$27,027,012, which is equivalent to more than one-half of the total annual production of lead in the United States. The largest item of income for the company was copper, the sale of which brought \$92,356,662, equivalent to over 35% of the country's production last year. The total cash receipts of the company for the year from all sources, principally from the sale of metals, was \$232,281,182. This is considerably more than the annual production of gold in the Transvaal. Dividends paid by the A. S. & R. Co. in 1915 were \$8,002,964; its preferred stock brought 7% and the common stock 4%. The smelters controlled by the company include lead smelters at Omaha, Denver, Pueblo, Leadville, Murray in Utah, East Helena, Kansas City, Selby in California, Monterey and Chihuahua in Mexico. Among the copper smelters controlled are those at Perth Amboy in New Jersey, Hayden in Arizona, Garfield, Tacoma, El Paso, Baltimore, and Aguascalientes in Mexico. The board of directors has 30 members, five of whom are members of the Guggenheim family.

The Murex Flotation Process

This process was invented and patented by A. A. Lockwood. Various blends of crude oils are used in the proportion of 15 to 20 lb. (or $\frac{3}{4}$ to 1%) of oil per ton of ore, to which is added an equal quantity of magnetite, ground to 100-mesh. This mixture of oil and magnetite forms a permanent paint, which, no matter how finely it may be divided or broken up, will always be found to be composed of the two substances in the same ratio. The selective affinity of the oil in the magnetic mixture enables it to adhere to any particle of valuable mineral, either sulphide or oxide, contained in an ore, with which it may come in contact, forming a rich magnetite-oil-mineral mixture containing little or no worthless gangue.

In practice the crushed ore and water, together with a regulated quantity of oil mixture, are fed through a horizontal tube revolving slowly, which contains several hundred pounds of $\frac{1}{4}$ -in. rough iron shot. The shot becomes oiled and collects the mineral particles, both fine and coarse, in the form of a paste that adheres. This paste is continuously broken away from the shot by attrition and flows with the pulp through a screen at the opposite end of the agitator-tube onto a shaking tray which feeds it under a powerful electro-magnet. The coated mineral particles are attracted by the magnet from the flowing stream of pulp to the under side of an endless belt traveling under the magnet at right angles to the shaking tray, thereby suspending them until they are carried out of the magnetic field, when they are washed off by a spray of water, into a concentrate-box provided.

The points of advantage claimed for this process are: first, the ore need only be ground fine enough to free the mineral particles from the gangue, in some cases being crushed only to 5 mm.; second, both sand and slime are treated together in one operation, so that no classification is necessary; third, this process is suited to the treatment of practically all the sulphide ores, and also successfully treats lead, copper, and zinc carbonates and oxides, making extractions up to 93% in some cases.

IN RHODESIA, during the first quarter of 1916, the Eldorado Banket Gold Mining Co. had the following metallurgical results:

Stamps dropping 65.01 days	20
Chilean mill crushing 77.78 days	1
Pans grinding 87.98 days	4
Total ore reduced, tons	12,212
Gold by amalgamation, ounces	5,439
Gold by cyanidation, ounces	1,533
Cost:	
Stamps and Chilean mill	\$0.72
Pans	0.36
Sand treatment	0.13
Slime treatment	0.32
Total	\$1.83

The ore averaged \$11.51 per ton, of which \$6.48 was profit.

Snake Creek Tunnel, Utah

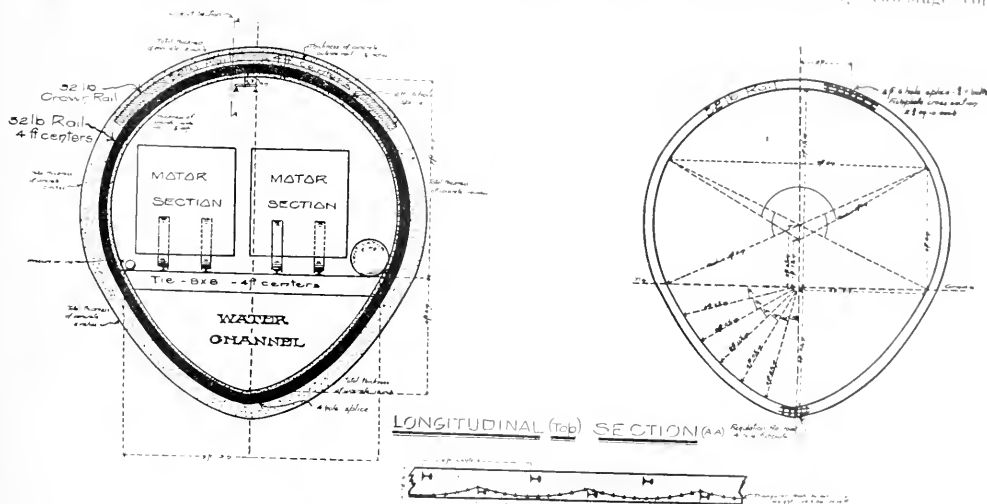
This $2\frac{3}{4}$ -mile adit for draining mines was completed recently near Midway, which is a few miles south-east of Salt Lake City and close to the Cottonwood and Park City districts, in Utah. The interesting features included the concreting of 300 ft., where swelling ground gave trouble, and the overcoming of difficulties due to excessive wetness and hardness of the rock.

The adit was driven by the Mid-West Tunnel Co. on contract for the Snake Creek Mining & Tunnel Co. The purpose is to develop and drain the mines of the latter company, of the Daly-Judge Mining Co. (now the Judge Mining & Smelting Co.), and the Knight claims in the

tunnel for 900 ft. when a contact zone of hard marble and quartzite cut by numerous tongues of basic igneous rock was penetrated. At 10,193 ft. from the portal the adit entered the Clayton-peak diorite stock and has been in this formation ever since. It is a dense tough formation, and very wet.

POWER: Electricity was furnished by the Utah Power & Light Co., which operates a power-plant a mile below the portal, and uses the drainage-water to generate power. Power was supplied at 440 volts.

COMPRESSORS: These were situated at the portal. One Sullivan two-stage type, size 18 by 11 by 14; rated capacity 650 cu. ft. at sea-level, belted to a 100-hp. General-Electric induction motor. One Bury two-stage com-



THE CONCRETED SECTION OF THE SNAKE CREEK TUNNEL.

Park City and Cottonwood districts. Details of the work are furnished by the Judge Mining & Smelting Company.

LENGTH: 14,500 feet.

ELEVATION OF PORTAL: 6932 ft. above sea-level.

GRADE: 0.25%.

WATER-CHANNEL: $3\frac{1}{2}$ ft. deep by 4 ft. wide. Capacity, about 30 second-feet. The theoretical capacity is somewhat larger, but the depth is decreased by a deposit of fine mud.

TIMBER: 10 by 10-in. Oregon-fir caps and posts. Posts are given a slight batter and are set on the solid ground in niches. Caps are not framed, but are set on the posts and wedged in place and a 2-in. spreader is nailed on the bottom to keep the posts in place.

CONCRETE: Swelling ground was encountered about 3000 ft. from the portal. The formation was black limestone cut by porphyry. Timber failed to hold, so about 300 ft. was concreted.

ROCK: Near the portal is limestone dipping 20° north-west, and parallel with the line of the adit. This con-

pressor, size 20 by 12 by 12; rated capacity 900 cu. ft. at sea-level, belted to a two-speed G. E. induction motor of 75-150 hp. Both compressors are connected to a 4-in. delivery-pipe that enters the receiver in the compressor-house and goes then into the adit.

VENTILATION: A No. 5 Root rotary-pressure blower is in the compressor-house at the portal, connected to a 16-in., No. 16 gauge, galvanized-iron pipe, and runs as an exhaust. The blower has a displacement of 196 cu. ft. per revolution, with a speed of 255 r.p.m. and is therefore drawing nearly 5000 cu. ft. of air per minute. Blower is belted to a 35-hp. G. E. induction motor. Ventilation is also helped by a small booster-fan, at the 12,000-ft. point, belted to an air engine. Ventilator-pipe comes in rolled sheets, and the pipes are made by the dump-man at odd times, into 15 ft. lengths with a slip-joint wrapped with canvas and tar. The average temperature in the adit is 55 F. The highest temperature occurs at 5000 ft., where hydrogen-sulphide gas is generated. Temperature here is 59 F. Lowest temperatures in some of the wet places do not go below 52 F.

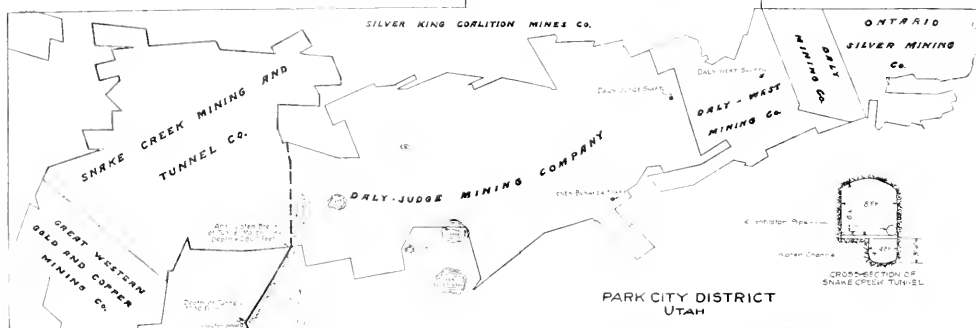
DRILLING: Formerly No. 8 Leyner drills were used but were replaced by No. 60 Dreadnaught drills. Three drills were mounted on a horizontal bar and operated on an air-pressure of 110 lb. A round consists of 18 to 24 holes varying with the hardness of the rock. Depth of holes drilled, 7 ft. Ground hard and tough, and the drilling cycle usually exceeds eight hours. Water is supplied to the drills from an old receiver placed under a permanent flow in the adit and usually kept within 1000 ft. of the face. Water is piped into the heading from the receiver. Floor of heading is carried 6 in. under grade, so as to facilitate the laying of track and make less drilling in the ditch. Jack-hammers have been used in the ditch. Holes are drilled 2 ft. apart in a single line about a foot from the wall. Ditch-drillers become expert and there is no trouble about breaking the whole ditch at one shooting.

TRAMMING: Broken ore is shoveled off steel sheets into cars of 20-cu. ft. capacity. Gauge of track is 18 in. Tramming is done by mules. There

PROGRESS: Average progress per month for the last two years has been 337 ft. The greatest progress in one month was in August 1915, when 436 ft. was made. The Snake Creek Tunnel is not a place to break records. The ground has always been difficult, and water troubles prevent speed. Since passing 3000 ft. the working has been almost continuously wet, and unusual trouble has been experienced since entering the diorite. Here nearly every crack is saturated with water, frequently under

heavy pressure. Often there are intersecting cracks that make the ground loose and blocky and a good deal of timber is required.

Trouble comes in the heading where a rush of water is encountered. After draining for a short time the pressure is reduced, the cracks



is a switch at 11,500 ft. and a mule works each way from this point. Eight cars are hauled into the heading at a time; the full cars are run into the heading out of the way and the empties are thrown off the track at the side. The mule is then hitched to the full train and takes it out to the switch. In loading the empty cars the one farthest from the heading is thrown back on the track and loaded first, then run out past the other empties and the second one is loaded. The ditch is carried about 150 ft. back from the heading so as to leave enough room to remove the empty cars. The crew usually loads two cars while the other shovelers in the heading are loading six.

The cars have roller-bearings, and the mule hauling from the switch outside has no trouble in handling a 20-car train. It takes about 2½ hours to make a trip from the switch to the dump and back, including the dumping of the train. The track is laid on the solid ground on the opposite side of the adit from the ditch. Long sills are laid 5 ft. apart with short sills spaced between them. Permanent sills are usually kept within 25 ft. of the end of the ditch. Carrying the floor in the heading 6 in. low always leaves a little hill in the track for the inside mule to pull over, but he manages 8 cars.

become plugged with sand and the flow subsides, but when first struck the tendency is for the rock to cave, and it is often necessary to use long 8 by 8-in. crown-bars to hold the back until sets can be put in.

Great Britain's Mineral Output

Production of the principal minerals in England, Scotland, and Wales last year was as follows, in tons:

Mineral	1915	1914
Barium compounds	60,801	45,910
Bauxite (alumina)	11,723	8,286
Clay, etc.	322,708	531,000
Coal	253,179,446	265,643,030
Fire-clay	1,829,746	2,374,068
Fluorspar	25,577	24,688
Gold ore	5,086	47
Gypsum	204,574	220,096
Iron ore	7,876,105	8,984,492
Lead ore	20,698	25,988
Limestone	287,680	334,779
Manganese ore	4,640	3,437
Oil-shale (Scotland)	2,998,652	3,268,666
Tin ore (dressed to say 60%)	6,420	6,635
Tungsten ore	329	205
Zinc ore	12,057	15,419

Simple Tests for Potash

By W. B. Hicks

DETECTION. Potassium is generally found in nature in solution, as soluble salts or saline residues, in organic substances, in alunite, and in silicate rocks and minerals. The following tests have been used by members of the U. S. Geological Survey and may be used successfully, it is believed, by anyone with a little experience in chemical manipulation. They depend on the fact that when a volatile potassium compound is heated in a flame it imparts a characteristic violet color to the flame. Though usually masked by the colors produced by other elements, especially sodium and calcium, the coloration due to potassium is readily seen and identified by observing the flame through a Merwin color-screen.

The equipment¹ necessary for making the tests consists of: (1) Lamp for volatilizing the potash compound. For this purpose an ordinary alcohol lamp with an asbestos wick will often suffice, but a gasoline or alcohol blast-lamp, which requires no wick and which burns with a hot, non-luminous flame, gives far better results. (2) Platinum wire 4 in. long. One end of the wire should be sealed into the end of a short glass rod to serve as a handle, and the opposite end should be bent into the form of a small loop. (3) Merwin color-screen.² (4) Small beaker. (5) Hydrochloric acid. (6) Gypsum or calcium sulphate.

First clean the loop of platinum wire by dipping it in hydrochloric acid and igniting it until the flame is no longer colored. By means of the clean platinum loop remove a drop of the solution to be tested, carefully evaporate it to dryness by holding over the flame, finally ignite, and observe the color of the flame through the Merwin color-screen. The best results are obtained by using a black background, holding the Merwin screen close up against the eyes, and looking through the central section of the screen. If potassium salts are present, the flame will appear reddish to reddish violet, and the intensity and duration of the color will give some idea as to the amount of potassium.

PROCEDURE FOR SOLUBLE SALTS. For detecting potassium in saline residue and soluble salts in general, as well as for detecting soluble potassium compounds in muds, clays, and ashes, proceed as follows: Dissolve a portion of the sample in a small quantity of water, allow the undissolved material to settle out, remove a drop of the clear solution by means of the loop of platinum wire,

and test in the flame as just described for waters and brines.

In tests for alum and other sulphates the clear solution should be poured off from the insoluble residue and some hydrochloric acid added before making the test.

The water used in all such tests should be examined to see whether it contains potassium, as a precautionary measure.

PROCEDURE FOR ORGANIC SUBSTANCES. The substance to be tested is first ignited or burned at as low a temperature as possible until only the ash remains. The ash is then tested for potassium according to the procedure just described for soluble salts.

PROCEDURE FOR ALUNITE. Powder the sample to be tested and moisten it with hydrochloric acid. By means of the loop of platinum wire transfer a portion of the moistened powder to the flame, ignite, and observe the color of the flame through the Merwin color-screen. If potassium is present, the flame will appear deep reddish violet.

Emphasis should be placed on the fact that this procedure is a test for potassium and not necessarily for alunite. Other potash-bearing materials, especially leucite and glauconite, will give similar results with such treatment.

The following simple field-test for the mineral alunite has been suggested by W. T. Schaller. Boil the powdered sample with water or with hydrochloric acid for several minutes; after allowing the powder to settle, pour off the liquid and repeat the operation to insure the removal of all soluble sulphates. Dry the powder and heat to dull redness. Again boil in water and, after settling, pour off some of the clear liquid. To this add a small fragment or a solution of barium chloride. If the mineral is alunite a heavy white precipitate will form. To be sure that the water used in this test does not contain sulphate in solution, it should be tested with barium chloride, and if it gives a marked precipitate it cannot be used.

For this test all that is required that was not included in the equipment for the detection of potassium is a little barium chloride, a small crucible in which to ignite the mineral, and a support for the crucible.

PROCEDURE FOR SILICATE ROCKS AND MINERALS. In order to detect potassium in silicate rocks and minerals, such as feldspar, granite, leucite, rhyolite, glauconite, and sericite, powder the material finely, mix with an equal quantity of pure gypsum, and moisten the mixture with dilute hydrochloric acid. By means of the loop of platinum wire, transfer a portion of the moist mixture to the flame, ignite, and observe the color of the flame through the Merwin color-screen. The red-

¹The equipment here described, except the Merwin color-screen, may be purchased reasonably from most dealers in chemical and laboratory supplies.

²The Merwin color-screen is manufactured and sold by G. M. Flint, 84 Wendell street, Cambridge, Massachusetts, for 25 cents. Hand spectrosopes may be used instead of the Merwin color-screen. These may be had from most dealers in laboratory apparatus at \$7 or more.

dish-violet color will be apparent if potassium is present.

Although with less satisfactory results, as a rule, the test may be carried out by mixing the material to be tested with either hydrochloric acid or gypsum alone.

ESTIMATION. A rough quantitative determination of the soluble potash in any salt may be made according to the method described below. To obtain even approximately correct results the conditions in making up the standard and in carrying out the actual determination on the unknown salt must be exactly the same.

The extra equipment required for this work is a small balance and a measuring cylinder. A hand spectroscope in place of the Merwin color-screen will probably give better results.

Dissolve 1 gram of pure potassium chloride in 10 cc. of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine through the Merwin color-screen. Gradually dilute the solution with measured amounts of pure water, mixing thoroughly and testing in the flame for potash the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the standard solution by *S*.

Dissolve 1 gram of the salt to be tested in 10 cc. of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine the color of the flame through a Merwin color-screen. Now gradually dilute the solution with measured amounts of water, mixing thoroughly and testing in the flame the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the unknown salt by *X*.

To obtain the percentage of potash expressed as potassium chloride in the unknown salt, divide the volume of the unknown solution at which the potassium flame could no longer be seen, designated *X*, by the volume of the standard solution at which the potassium flame could no longer be seen, designated *S*, and multiply the result by 100. In other words,

Percentage of potassium chloride (KCl) =

$$\frac{\text{Volume found for unknown salt}}{\text{Volume found for standard salt}} \times 100 = \frac{100X}{S}$$

Percentage of potash (K_2O) =

$$\frac{63.5X}{S}$$

Percentage of potassium (K) =

$$\frac{52.44X}{S}$$

GRAPHITE mining is on the increase in Clay and Chilton counties of Alabama, and near Burnet in Texas. The mineral occurs as small flakes in crystalline schist into which some granite pegmatite has been injected. Weathering to 50 ft. in Alabama has reduced milling difficulties.

Belt-Conveyors

Belt-conveyors were discussed recently by A. Robertson and A. McA. Johnston before the South African Institution of Engineers. Two kinds of belts were stated to be in general use, balata and rubber. In normal times a rubber belt costs about 15% more than a balata belt. A balata belt is made of several plies of canvas with balata gum impregnated between the layers. A rubber belt is made of several plies of padded canvas with a covering of rubber on the upper and under sides and edges. It should be recalled that the figures given by these Rand engineers apply to the handling of quartz ore, which is sharp and destructive of belts. For an approximate figure it was found, from average of a number of both kinds of belts, that the cost of the belt alone for handling broken rock was about 30 cents per foot per month, while the cost of the belt for handling sand was about 14½¢. per foot per month. Among the detailed statistics given was that of a 24-in. rubber belt, 182 ft. long, 6-4 ply, which carried sand for nearly six years at the rate of 68 tons per hour, a total of 1,586,764 tons; this belt cost \$3.72 per ft., and the cost of the belt alone was 5½¢. per ft. per month. This is an unusually low cost for Rand practice. As an example of a high cost for carrying fine crushed ore to the mill, a 30-in. rubber belt, 923 ft. long, 7 ply, with ½-in. rubber face, was in service 18 months, carrying 117 tons per hour, a total of 854,000 tons. The cost of the belt alone was 28½¢. per ft. per month; the belt had cost \$5.84 per ft. originally. A balata 30-in. belt, 291 ft. long, 6 ply and with 7 rows of copper stitching, conveyed fine crushed ore for 672 days; the tonnage per week of 54 hours was 5000 tons, and the total amount carried was 397,546 tons. The cost of the belt alone was 11¢. per ft. per month; the cost per ton of material carried was 18¢., and the original price of the belt was \$2.44 per ft. This cost per ft. per month is low for balata belts carrying fine quartz. As to life of belts, a balata 24-in. belt, 750 ft. long and 5 ply, original cost \$1.26 per ft., was used for conveying dump ore to the stamp-mill from a Rand gold mine, operating on an incline of 18° at a speed of 350 ft. per minute; it carried nearly 50,000 tons per month for 27 months, a total of 1,200,000 tons. The quality of the rubber is of the greatest importance in determining the life of a rubber belt.

THE NEW CORNELIA Copper Co., which is opening a copper mine at Ajo, Arizona, estimates that its orebody contains 11,950,000 tons of 1.54% oxidized ore and 28,303,600 tons of 1.50% sulphide ore, a total of 40,258,000 tons averaging 1.51% copper. No overburden exists and the ore is mostly in a series of small hills. For the leaching process of treatment with sulphuric acid the ore is crushed only to 4-mesh.

THE UNITED VERDE EXTENSION MINING Co.'s first dividend of 50 cents per share happens to be exactly equal to the par value of the stock.

Mining in Utah

By L. O. Howard

The embargo on silver-lead ore has been made more rigid. In addition to the curtailment of shipments from Tintie, ordered by the smelters, reference to which was made last month, this restriction has now been extended to most of the other small shippers in this State. Those who have leases or are small mine-owners dependent on frequent shipments for meeting the pay-roll are in a quandary. The lead smelters, having accumulated a large tonnage of high-priced ore, have the situation entirely in their own hands, and the wishes of producers are not likely to have much weight. The only possible thing to do is to await the smelters' own good time. A year ago I went into details of smelting and roasting capacity and showed the possible limits on production. That the curtailment was postponed so long was due to the willingness of the smelters to fill their yards with ore, and it is this accumulation that is also the cause of present conditions, and prevents an early release of the embargo.

Combined with the embargo on lead-silver ore, the poor market for zinc, antimony, and tungsten has helped to burst get-rich-quick booms. Many small owners were making an inflated profit, and dreaming of it as unending. Their awakening has been rude. However, many mines are now able to ship on a lower market that would never have started had prices remained normal. Dealing in shares is dull, so that mining is attracting less attention than a year ago. The strongly fortified producers continue to accumulate large profits. The Utah Copper is breaking all records, the latest being 44,000 tons of ore mined in 24 hours, with 25,000 tons of overburden removed the same day.

Mining prosperity is based on the profitable operations of the rank and file, and it is idle to expect better conditions during the hot season. The share-market is marked for dullness until the man on the street is again interested in something besides the cool breezes and the lure of the trout in the near-by canyons, where he so forgets his interest in mining as to bewail the clatter of the ore-teams.

The road in Big Cottonwood canyon is now in good condition, bridges have been re-built, grades cut down, and all is ready for the experiment with tractors, five of which are at the transfer point of the Cardiff mine at the mouth of South Fork. The first loads will probably be hauled before this letter is in print. Development continues in both the Cottonwoods, but without any startling results. Mines that were made last year are shipping large tonnages, but no new ones have been opened. In Big Cottonwood, the Cardiff and Maxfield continue to do all the shipping. The former will increase its daily rate from 120 to 300 tons as soon as the traction-engines have been established. The Maxfield mine has made a record of two cars per week of ore netting \$100 per ton, and is opening ore faster than it is

being shipped. The stock accumulates little more on account of the heavy tonnage issue.

In Little Cottonwood the South Hecla, a first mortgage payer, is producing the largest tonnage, with other shipments coming from the Alta Con. and Michigan Utah. Some zinc-silver ore has been shipped from the Woodlawn, just over the divide in Big Cottonwood from Alta. This ore averages 27% zinc, 7% lead, 16 oz. silver per ton.

American Fork canyon is in full swing. Three shifts are at work driving adits on the Miller Hill, Duteau and Whirlwind mines. Ore is being broken on the Pacific and on the Bay State. The Texan, Earl Eagle, and Belerophon are developing promising fissures. The Alpine Empire, Stewart, Mountain King, Silver Flat, Wasatch King, North Star, American Fork Con., Silver Dipper, Snuggler, Utah-Centennial, South Fork, Pacific Extension, and Major Evans are employing three to six men each.

Tintie and Park City are shipping heavily despite the curtailment. There is no abatement in new construction at Park City, where long adits are being driven, new mills erected, and old plants re-modeled for larger capacity. Work is being rushed on the electrolytic-zinc plant for the Daly Judge, details of which have already appeared in the PRESS.

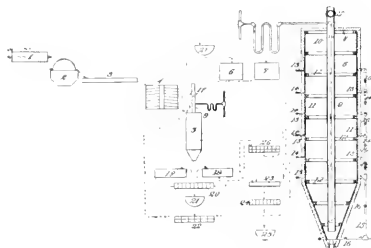
Signs of the new leaching-plant of the Utah Copper may now be seen. Two steam-shovels are excavating a mill-site just above and west of the Magna mill, on a spur of the Bingham & Garfield railroad, thus affording excellent transportation facilities. Details of the process are not yet public.

Stress has been laid upon the increased metal output of Utah by the Geological Survey's report for the first half of the year. Its rosy predictions appear warranted by the dividends, which totaled \$10,915,000, an amount in excess of that for the whole of 1915. Utah Copper is the heaviest contributor, having paid \$8,231,500 to July 1. Whether a record of \$20,000,000 shall be made for the year depends upon the performance of this one company. Since its copper is sold well ahead at high prices, and production is heavy, it is probable that its total will be surpassed. Fourteen other companies contributed to the record. They are the Centennial Earle, Chief Consolidated, Iron Blossom, Gemini, Mammoth and May Day, of Tintie, with a total of \$1,083,000, the Utah Copper, Utah Consolidated, and Utah Apex, of Bingham with a total of \$9,579,500; Daly Judge, Silver King Consolidated and Silver King Coalition, of Park City, with \$697,500; La Cygne, of Panguitch, with \$345,000, the Horn Silver of Beaver County with \$200,000, and the California of Big Cottonwood, with \$125,000.

Electric power is supplied by the Pacific Gas & Electric Co., the fifth largest concern of its kind in the United States, to the mining industry. It is the largest of its kind financial year (1915-16) to \$6,071,000. It is a combined \$59,126 over that of the previous year, its highest expansion in mining operations.

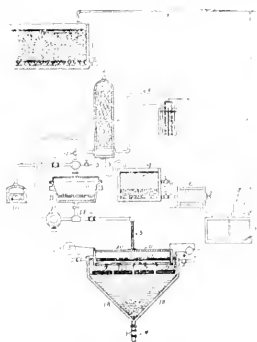
RECENT PATENTS

1,185,502. PROCESS OF TREATING ORES. Royal S. Handy, Kellogg, Idaho. Filed Oct. 28, 1911.



1. The process of treating sulfid ores containing lead which comprises roasting the ores, extracting the lead sulfate with an aqueous solution of sodium chlorid, extracting other metal constituents with an aqueous solution of iron chlorid, and recovering the lead and other metal constituents from such solutions.

1,186,306. PROCESS OF EXTRACTING METALS FROM THEIR ORES. William E. Greenawalt, Denver, Colo. Filed May 7, 1912.



A process which consists in dissolving copper from its ores with an acid solvent; applying hydrogen sulfid to the resulting copper solution to precipitate the copper and regenerate acid; separating the regenerated acid solution from the sulfid precipitate and returning it to the ore to dissolve more copper; treating the sulfid precipitate to recover the copper and elemental sulfur; treating the elemental sulfur to convert it into a precipitant, and then applying the precipitant so produced to precipitate the copper dissolved by the regenerated acid solution.

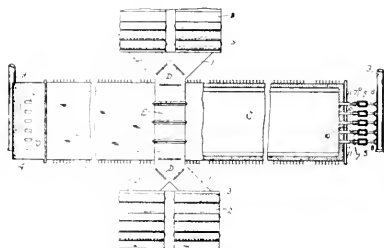
1,185,995. PROCESS OF TREATMENT OF ANODE-SLIMES AND SIMILAR MATERIALS. Francis C. Ryan, Hammond, Ind., assignor to one-half to United States Metals Refining Company, Chicago, N. J., a Corporation of New Jersey. Filed Feb. 24, 1911.

1. The method of treating mineral bearing material containing arsenic, selenium, gold, silver, copper and the like comprising roasting the slime with alkali carbonate, leaching with water, filtering to eliminate the arsenic and selenium,

and roasting the residue in the presence of sulfuric acid to sulfate the silver and copper for separation from the insoluble gold.

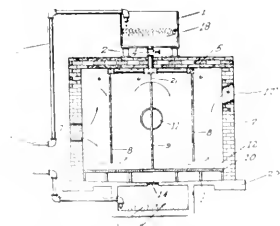
2. The method of treating mineral bearing material containing arsenic, selenium, gold, silver, copper and the like, comprising roasting the slime with sodium carbonate at a temperature which will complete the reaction of the materials before the mass sinters, leaching the sintered mass, filtering to remove arsenic and selenium, and roasting the residue in an oxidizing roast in the presence of sulfuric acid to sulfate the silver and copper, and separating the gold from the silver and copper.

1,186,104. FURNACE. William M. Kelly, Anaconda, Mont. Filed Dec. 18, 1915.



1. A metallurgical furnace comprising two reverberatory furnaces disposed back to back and in longitudinal axial alignment, the same forming a single treatment chamber arched across the longitudinal axis of the chamber, a central transversely disposed waste flue leading from and spanning said chamber, and means on the longitudinal axis at each end of the chamber for firing the furnace.

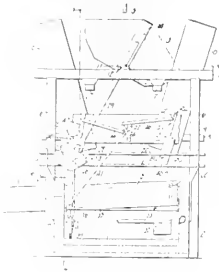
1,188,237. RECOVERING NOXIOUS AND OTHER MATERIALS FROM SMELTER-FUMES. Clarence Barrett, Salt Lake City, Utah, assignor of one-half to George Morrow, Salt Lake City, Utah. Filed Jan. 15, 1915.



1. The process of treating smelter fumes for the elimination of sulfur dioxide therefrom and the recovery of volatile metallic values, consisting in subjecting the smelter fumes on their passage from the furnace to the atmosphere to the action of a solution of bisulfid of an alkali or alkaline earth metal, thereby converting sulfur dioxide contained in the fumes into a soluble salt by the alkali contained in the solution, and also precipitating the soluble metal combinations in the fumes in the

form of insoluble salts of the metals and collecting such insoluble metallic salts separately from the solution.

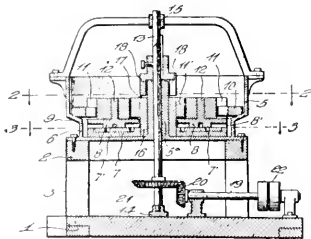
1,188,794. TAILING-SAMPLER. Charles L. Lawton, Hancock, Mich. Filed May 19, 1915.



1. In combination, a launder for transporting material by liquid, and fluid pressure means operated by a fluid other than the liquid by which the material is transported for automatically taking and elevating samples of the material at predetermined intervals.

2. In combination, a launder for transporting material, suction means movable transversely of the launder for automatically taking and elevating samples of the material, and means for moving the suction means back and forth with reference to the launder.

1,186,709. DOUBLE-ACTING GRINDING PAN-MILL AND AMALGAMATOR. Charles Davey Tregoning, Grass Valley, Cal. Filed Oct. 28, 1915.



1. In an ore pulverizing machine the combination of an ore receiving pan, a bed plate mounted in the bottom thereof, grinding disks mounted to revolve flatwise on said bed plate, a central gear arranged therein, a plurality of gears mounted on and fixed to said disks and surrounding and meshing with said central gear, and means for rotating said central gear.

1,191,053. PROCESS OF CONCENTRATING METALLIC ORES BY FLOTATION. Homer T. Varyan, Toledo, Ohio. Filed Mar. 29, 1916.

1. The process of concentrating metallic ores which consists in agitating the ores in comminuted form in a mixture of water, oil and a suitable resinate, and then, by flotation, recovering the froth thus produced together with its accompanying metallic particles.

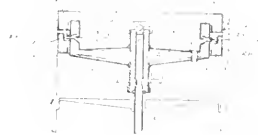
3. The process of concentrating metallic ores which consists in agitating the ores in comminuted form in water to which is added a mixture consisting of sixty-five per cent. oil and thirty-five per cent. resinate of soda, petroleum emulsifying upward of fifty per cent. of the whole, and then by flotation recovering the froth thus produced together with its accompanying metallic particles.

1,190,401. BALL-MILL. Ernest S. Gregor, Anderson, Ind. Filed Nov. 18, 1915.



1. The combination with a tumbling barrel rotatable about a fixed axis and having a crushing compartment provided respectively with intake and discharge openings for the material disposed about said axis, a pulley adapted to be charged from the exterior and provided with an axial tubular member discharging the material to be crushed into the compartment aforesaid, a stationary holder for the crushing bodies provided with a discharge opening and a ball-feed tube leading from said opening and discharging into the tubular member aforesaid.

1,190,466. APPARATUS FOR SEPARATING MATERIALS OF DIFFERENT SPECIFIC GRAVITIES. Charles Schifferle, San Francisco, Cal., assignor to The Yuba Construction Company, San Francisco, Cal., a Corporation of California. Filed May 18, 1915.



1. An apparatus of the character described, comprising a rotatable annular casing, means for introducing fluid into said casing to fill the same, an annular pocket formed in the inner wall of said casing and a lip on the casing extending into said pocket, the lip being spaced from the wall of the pocket to permit fluid to flow from the casing into the pocket.

1,190,224. APPARATUS FOR THE SEPARATION OF OIL, SAND AND WATER RAISED IN DREDGING GRAVEL. Leon De la De De la Paul Armand Dronard, Rouen, France. Filed Apr. 1915. Serial No. 687,922. Renewed Feb. 11, 1916.



A separator of the character described, comprising a vertical cylindrical casing which forms the bottom of the separator, a vertical shaft passing down to the bottom of the bowl, several vertical disposed walls which are provided with hinged doors, and form the walls of an annular compartment concentric with one of which is open to permit the oil to pass thereat, a stream of dredged sand, gravel and water, to be introduced through which the dried sand passes, to the bottom and out through a discharge pipe, off the side of the separator, and water flowing through the walls from the bottom of the separator.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

MINE-WATER usually contains fine sand or grit in suspension. Engineers in South Africa, who have examined microscopically the grit in the water from Rand mines, find that the particles possess sharp corners that prove destructive to pump-valves and piping. The rock mined there is quartz.

HAULAGE in mines by compressed-air locomotives with storage-tanks is 3 cents per ton cheaper than by horses, mainly due to less labor, according to Raoul Green in a paper for the Canadian Mining Institute. The cost of supplies and depreciation are about the same in each case. Compressed air permits of from two to three times more ore being handled than by horses.

LOW-GRADE lead ore is mined in south-eastern Missouri. The average lead content is about 3%. Comparing this with low-grade copper ore, such as the 1% ore of Michigan, it is seen that the grade varies inversely as the price. That is, lead is ordinarily sold for 4 or 5c. per lb., while copper sells for 12 to 15c. per lb., or three times as much. Inversely, 3% lead ore and 1% copper ore are about the lowest grades mined.

DIAMOND-DRILLING costs are low in the lead-mining field of south-east Missouri. They average only 75c. per foot, varying usually from 60c. to \$1. Of a cost of 75c., about 25c. would be paid for labor, 25c. for diamonds, 10c. for fuel, and 15c. for repairing and miscellaneous items. These low costs are due to the consistently regular structure of the limestone, which is free from flint, and to the excellent labor and cheap fuel available. Drilling in the region is active at this time.

THE GOLD-SCHEELEITE ore of the Golden Point mine, at Maerua, in the South Island of New Zealand, is higher in gold when the tungsten-content is low, and the reverse. A chart, covering 1906 to 1913, when the average content of 41,435 tons was \$2.88 gold per ton and 0.66% scheelite, shows this peculiarity of the ore to a marked degree, except in 1911-'12. Exceptions to this rule are sometimes evident when 50% WO_3 specimens have free gold adhering to them.

SHOOTING of wells with dynamite, which the California State Mining Bureau has recommended as an experiment with a view of increasing production from the shale in the Santa Maria field, is giving encouraging results on the Western Union property where well No. 41 was shot. Strings of torpedoes 50 ft. long, and carrying 300 lb. of gelatin were used. Six shots were set-off. The well was dry before shooting, and during the subsequent cleaning out and intermittent pumping is said to have

produced from 50 to 75 bbl. of oil per day. It is planned to try the experiment at several other wells. The Santa Maria field is one of the few in California where the ground stands up well enough to require or even permit shooting.

AN AUTOMATIC electric hoist is giving satisfaction at the Inspiration mine in Arizona. A particular feature is that the motor is so fully controlled automatically that the hoist is started and stopped with a minimum of assistance from men. The reduction of labor in loading by an automatic system at the foot of the shaft also decreases the cost of operation. All the ore is raised from one level, which is 630 ft. deep; from 10,000 to 14,000 tons is hoisted per 14 hours. There are two vertical shafts a short distance apart, with two electric hoists of Nordberg type. A motor-generator set eliminates peak-loads. Each hoist is driven by a 580-hp. direct-current motor through a flexible coupling and Falk gear.

ECONOMY in mill supplies has become imperative owing to the increase of cost, due to the War. We read with interest in the report of the Redjang-Lebong company, operating in Sumatra, that during 1915 the manager had been able to economize on the most expensive item, cyanide, by thickening the slime introduced into the treatment plant and only using enough cyanide to get the gold and silver into solution. It was then found, that while an efficient precipitation could be maintained in the zinc-boxes under steady working conditions, it became necessary to increase gradually the strength of the solution in order to maintain the precipitation under the intermittent working conditions prevailing. As an alternative to increasing the strength of the working solutions so as to maintain the precipitation, the inert zinc could be removed from the boxes, but this also was at an enhanced cost due to the greatly increased price of zinc and the difficulty of obtaining sulphuric acid.

ATMOSPHERES that are deficient in oxygen begin to affect men when the amount of oxygen is about as low as that affecting canaries and mice. Canaries are slightly more susceptible to want of oxygen than are mice. In mixtures of air and nitrogen containing only 7.6 to 7.8% oxygen, canaries show pronounced distress. When the oxygen-content is about 7%, mice show considerable distress, and a man is in grave danger of dying; hence canaries and mice should not be used by exploring parties in mines to show when men unequipped with breathing helmets should retreat because the atmosphere is low in oxygen, according to G. A. Burrell and G. G. Oberfell of the U. S. Bureau of Mines. Mice and canaries, especially the latter, are chiefly of value for indicating to exploring parties the presence of dangerous proportions of carbon monoxide. In an atmosphere in which oil-fed lamps will not burn, an exploring party should not depend on canaries for further guidance, but should use breathing apparatus in advancing into the atmosphere.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

BUTTE, MONTANA

MINES OF THE EASTERN SECTION.—ANACONDA, NORTH BUTTE, BUTTE-DULUTH, TUOLUMNE, BUTTE GREAT FALLS, AND DAVIS-DAILY OPERATIONS.

There is great activity in all parts of the Butte district. The Northern Pacific will build a spur into the eastern section that will provide shipping facilities for several working mines now dependent on haulage by teams. Among the mines that will be benefited by the new spur are the Tropic and Greenleaf of the Anaconda company, the Colusa-Leonard and Butte Main Range under option to the Tuolumne company, and the Butte-Duluth, Bullwhacker, and Butte & London. Almost every company here is deepening one or more of its shafts, and work is being pushed on a large tunnel that will penetrate the continental divide three miles east of Butte. All the producing mines are hoisting ore at full capacity, and development companies are having no difficulty in obtaining funds for exploration purposes.

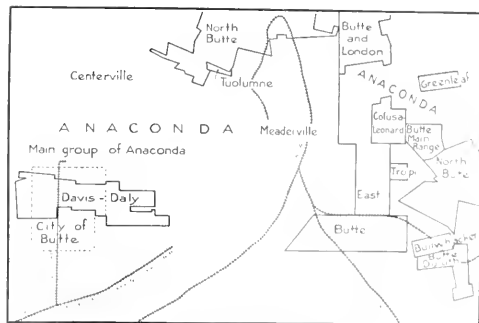
It is rumored that the electrolytic zinc plant of the Anaconda company at Great Falls will not be in operation before October 1. The experimental plant at Anaconda is turning out 25 tons per day of high-grade spelter. Since July, 100,000 additional shares of the Butte Copper-Zinc Co. have been taken up under the Anaconda's option at \$1 per share. The shaft at the Emma mine will be sunk to the 1600-ft. level, and will be in a position to make large shipments of zinc ore when the Great Falls plant is ready to receive it. A contract has been let to sink the Nettie shaft from the 500 to the 1500-ft. level. This will be the first deep development in the western part of the district, and will be watched with great interest as it is expected to give some idea of the possibilities of the production of zinc and silver in the surrounding properties. The United Copper Securities Co. has filed an amended complaint under the Sherman law against the Anaconda in the United States District Court at New York. The United Copper Securities Co. has acquired the copper interests of Otto Heinze and company. It is alleged that the defendants tried to influence the Montana courts to deprive Heinze illegally of his interests in Butte mines. Another charge is that in 1897 the defendants set fire to Heinze's concentrator and smelter and shut the water off for 1½ hours while the plant was burning. Damages were estimated at over \$1,000,000, and under the law three-fold damages were asked.

The recent slump in the North Butte shares was not due to unfavorable developments underground. Fifteen hundred tons of ore is being hoisted daily, and during June 2,096,326 lb. of copper and 90,713 oz. of silver was recovered. This is an increase over the May production of about 100,000 lb. and 2000 oz. Drilling on various levels has developed high-grade ore that materially adds to the reserves, and will tend to increase the grade of shipments. The Granite Mountain shaft is down below the 3500-ft. level, and it will probably be sunk to 3700 ft. The lower levels are hot, and several connections are being made to provide better air. The dividend rate has been increased from \$2 to \$3 per share per year, and at the present rate of production and 25-c. copper, the company is making a net earning of about \$7 per share. The surplus will be used for the purchase of new properties and for the further development of claims that have not been thoroughly explored.

The mine and mill of the Butte-Duluth company were closed-down by Court action when the company failed to pay the

interest on bonds held by the Providence Securities Co. of Duluth. The indebtedness amounts to \$875,000. The bond issue is for \$500,000, and the balance is made up of liens for wages, lumber, and machinery. Foreclosure proceedings were started with the idea of dismantling the plant, and selling the machinery to satisfy the claims for wages and lumber. The bond-holders, through their committee, filed a suit in intervention that held-up the foreclosure and sale of machinery. The high price of sulphuric acid for leaching makes it impossible for the receiver to operate the property at a profit. Efforts were made to obtain acid from the Anaconda company, but its output is at present limited to 100 tons per day, all of which is required for the operation of its own leaching plant. The Butte-Duluth was one of the pioneers in leaching in this country.

The Tuolumne company will sink the Colusa-Leonard shaft from the 800 to the 1600-ft. level, and cross-cut at that depth to the side-lines of the property, a total distance of 1800 ft. For the doing of this work the Tuolumne company will receive



PART OF EASTERN BUTTE.

51% of the shares of the Syndicate Copper Co., the holding company of which is the Colusa-Leonard. Each 80 ft. of shaft-sinking will be considered 1% of the total work to be done. One-half of the stock so earned will be paid to the Tuolumne at the end of each 60-day period, the balance when the work is completed, which is stipulated must be before May 22, 1919. The Colusa-Leonard is in the eastern part of the Butte district, near the Tropic mine of the Anaconda company. No work has been done on the property since 1907, but until that time development had progressed with encouraging results. The Tuolumne has taken an option on 1,000,000 of the 1,500,000 shares of the Butte Main Range Copper Mining Co., the average price being 65c. per share. Under the terms of the agreement \$10,000 per month is to be expended in development work. The shaft is now being enlarged and extended from the 700-ft. level to the surface. Good ore was encountered in the shaft, and it has been developed on the 500-ft. level, where it is reported to average 90 coppers. This ore will be extracted as soon as repairs to the shaft are completed. About 70 tons of copper ore is being shipped per day from the Tuolumne claim. Work is being hurried in a raise to connect the 200-ft. with the 2100-ft. level, to improve ventilation on the lower levels. It is then proposed to sink a winze in the less active

from 2600 ft., and if developments are favorable the shaft will be sunk to the 2800-ft. level.

The cross-cut south from the shaft on the 500-ft. level of the Butte Great Falls has cut the Dewey vein. A heavy flow of water was encountered, stopping work until the water-level is lowered. The cross-cut is over 700 ft. long and cut two other veins which did not contain profitable ore. Many of the richest veins at Butte are not productive on the upper levels, and the company will explore its veins at greater depth. The plans include a new shaft near the Dewey vein, to be raised from the cross-cut to the surface, and then it will be sunk to the 1000-ft. level. Application will be made to list the stock on the Boston curb.

Davis-Daly is hoisting about 100 tons of copper ore through its Colorado shaft. This is being mined on the 1400, 1500, and 2500-ft. levels. The ore from the upper levels averages 2.5%, but at 2500 ft. a drift has been put in over 400 ft. in ore averaging 5% copper. With the new hoist that is now being placed in position the output can be increased considerably. The old hoist is only strong enough to pull from 1700 ft., and it is necessary to hoist to that level with a station engine. Lessees on the Colorado dump have been able to sort ore that contains 2.5% copper and some silver.

At the Butte & Superior No. 2 and 3 shafts are down 655 and 1400 ft., respectively. Steel is soon to arrive for the 132-ft. head-frames. The June output was 10,830 tons of zinc concentrate from 48,475 tons of ore.

Butte and Eastern capitalists are to supply money for sinking a 1000-ft. shaft on a claim in Meaderville, east of the Cambert and Leonard mines.

The Butte & Bacon Copper Co.'s stock and property has been transferred to the Great Butte Copper Co., a re-organization company. A 90-ft. head-frame and steam hoist are to be erected at the Calumet shaft. The new company has a working capital of \$180,000, and no debts.

SUTTER CREEK, CALIFORNIA

PROGRESS AT OLD EUREKA.—KEYSTONE'S HALF-YEAR.—PLYMOUTH HOIST.—MAGNESITE AND COPPER.

Grading has commenced at the old Eureka mine for the new steel head-frame and hoisting machinery to replace the temporary arrangement that has been used up to the present in unwatering the mine. A good double-drum hoist has been purchased, to be on the ground by the time the foundations are ready. Meanwhile the work of unwatering and repairing the old shaft continues, this being in first-class condition for 130 ft., with the water removed 20 ft. below that point. The next improvement contemplated is a large timber-shed and modern saw-mill, excavation for which is now under way.

The semi-annual report of the Keystone Mines Co. at Amador City, to July 1, has been published, and is interesting in showing how low a grade of ore can be profitably worked under conditions prevailing here. The 41,018 tons treated yielded only \$1.98 per ton. In spite of this the company has in its treasury \$10,000 more than it had six months ago, after paying for mining, milling, taxes, and overhead expenses. The half-year's product consists of gold bullion, \$16,533; concentrate, \$89,688; and base bullion, \$1606. Freight and smelter charges on 1450 tons of concentrate amounted to \$17,391. The ore was taken mostly from the 900, 1200, and 1400-ft. levels, each of which produced from 10,000 to 13,000 tons, while 5602 tons was hoisted from the 1000-ft. level. Work has been temporarily stopped at 900 ft., and nothing has been done for several months at 800 ft., but veins of fair value, ranging in width from 6 to 15 ft., are showing on the 1000, 1200, and 1400 ft. levels, north of the shaft. Connections have been completed by raises from 1200 to 700 ft., affording good ventilation and increasing the miners' safety. On the 1400-ft. level, at a point 150 ft. north of the main cross-cut, the vein formed

two branches. Drifts have been driven on each of these, the face of the east branch now being in low-grade ore at a point 420 ft. north of the shaft cross-cut; and the west branch, which has followed the vein formation for about 650 ft., has now 8 ft. of ore in the face. Preparations are now under way for cutting a shaft station and chute at 1800 ft., from which an east cross-cut will be driven to the vein. Although the Keystone mine has been operated almost continuously since its discovery in 1851, until now it has had no chance to prove its value in depth, the deepest workings until three years ago having been but 1400 ft., or 1572 ft. on the incline, much nearer the surface than its neighbors north and south. The present company extended the shaft 1000 ft., and considerable interest is taken in the results to be obtained in exploring this ground. B. Hoxie is foreman, and C. R. Downs of Sutter Creek is general manager of this well-known mine, which was until recent years owned by M. J. McDonald of San Francisco. During the six months just ended, the mill lost only 2 days and 50 minutes on account of repairs, clean-up, and shortage of power, and the fact that only 6 hours of this lost time was due to power being off speaks well for present electrical service rendered in this district, a contrast with a few years ago.

During the week there arrived at the Plymouth Consolidated one of the finest hoists on the Mother Lode. It is to be installed immediately in place of the present machinery, which has proved somewhat inadequate for present requirements.

There appears to be some prospect of large deposits of magnesite being worked in this vicinity in the near future. John Beecher of San Francisco has been in Jackson for a few days examining several properties. It is said that there are valuable deposits of this mineral here awaiting development.

At the Allen copper mine, formerly known as the Hayward mine, three miles east of Ione, the shaft is down 500 ft., and preparations are completed for stopping a large block of this ore. The vein is 5 ft. or more in width, and contains gold as well as copper of profitable value. Large reserves of this ore have been blocked-out, and regular shipments will soon be made. C. N. Johnson of Sutter Creek is managing this mine for the Allen Estate Company.

TORONTO, ONTARIO

FURTHER CONTROVERSY ON NICKEL.

A keen political controversy has arisen over the policy of the Canadian government regarding the exportation of nickel matte for refining in the United States. The question was before Parliament several times last session, strong fear being expressed that the product of the Sudbury mines, once in the hands of Americans, would find its way to Germany. At that time the strongest assurances were given that sufficient precautions had been taken under an agreement with the International Nickel Co. to render this an impossibility, and that the British government was entirely satisfied with the arrangements. It was further stated that the company would without delay erect and operate a refining plant in Canada of sufficient capacity to satisfy the nickel requirements of the British Empire. The agitation subsided, but has been suddenly revived in greater force than ever owing to the announcement that the German merchant submarine *Deutschland* has taken on board a quantity of nickel purchased in open market in the United States. This, it is contended, must be from Canadian mines, as the United States is almost wholly dependent on the Dominion for its nickel. The topic has been taken up by the Liberal party, and will undoubtedly be a prominent issue in the next election. The position of the Government is one of great difficulty. If it were to yield to the clamor for a total prohibition of the export of nickel, it would not only prevent the possibility of Germany getting any, but it would cut off the supply of the American manu-

facturers who are making munitions for the Allies, and the establishment of a Canadian refinery would, it is stated, require at least three years. So far the Government has shown no disposition to adopt any more stringent measures. It justifies its position on the ground that it has received renewed assurances that the Imperial authorities are perfectly satisfied with the precautions taken to keep Canadian nickel from falling into German hands, and that the *Deutschland's* cargo must have been obtained from some other source. Meanwhile the International Nickel Co.'s representatives are examining ground in Ontario with a view of selecting a site for the proposed Canadian branch. The Mines Department of Ontario contemplates establishing a nickel refinery as a Government undertaking, and is conducting a series of experiments with two new patent processes.

Profits of the International Nickel Co. during the second quarter of 1916 were \$3,305,574. Preferred shares received \$133,689 in dividends. The surplus is \$5,171,885, equal to 7.58% on common stock. Cash amounts to \$4,137,633.

The Porcupine-Crown mill is treating 140 tons daily. A winze below 500 ft. is down to a depth of 730 ft. Sinking is to be done to 800 feet.

The Hollinger Consolidated Gold Mines has issued a state-

A flotation plant is to be installed by the Dominion Reduction Co. Callow apparatus has been ordered.

The Kerr Lake output for June was 237,912 oz. of silver.

The Beaver Consolidated is cross-cutting at 1600 ft. to explore the lower contact.

At Chippawa the new nickel refining plant of the Canada Nickel Smelting & Refining Co. is almost completed. Power is supplied from Niagara.

During the first half of 1916 the Teniskaming company did 2080 ft. of development. The main shaft has reached a depth of 1180 ft., a working station having been cut at the 1150-ft. level. Sinking will be continued until the lower contact between the diabase and keewatin formations is reached, which exists at a depth of 1600 ft. from the surface. On the upper levels of the mine, work is progressing favorably and some high-grade ore is being extracted. Cash on hand amounts to \$170,219, and bullion in storage and in ore 502,288 ounces.

REPUBLIC, WASHINGTON

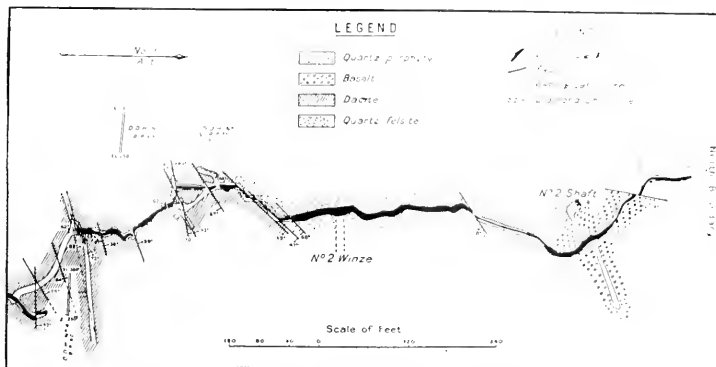
TRANSACTIONS OF IMPORTANCE TO THE DISTRICT.

It has been made public that the Day brothers, operating in Idaho and a smelter at Northport, have secured control of the Lone Pine, Pearl, and Surprise claims at Republic. Two instruments have been filed in the Ferry County auditor's office (1) a deed from George S. Bailey, trustee in bankruptcy for the Republic Mines Corporation, transferring the Lone Pine, Pearl, and Surprise claims, the final payment on which, amounting to \$82,000, was made on July 17; and (2) a mortgage on the same property to Jerome L. Day, of Wallace, Idaho, executed by A. B. Willard and A. J. Laughton, respectively as president and secretary of the Republic Consolidated Mines Corporation, to secure a loan of \$93,000, payable in one year and bearing interest. The provisions of the mortgage practically authorize the mortgagee to

direct the management of the property. The \$82,000 received by Mr. Bailey, as trustee in bankruptcy, will enable him to wind up the affairs of the Republic Mines Corporation during August and pay the creditors 100 cents on the dollar, and the shareholders of the Republic Consolidated Mines Corporation will receive a final dividend of about 50¢ per share.

In the Keller district work has been resumed in the Golden Crown mine adit with expectation of cutting the vein in less than 50 ft.—It is probable that the Addison mine, on Silver creek, will be soon reopened. If its good ore developed.—A shipment of ore is being dispatched from the Iron Creek mine on Iron creek.—The Manilla Creek bridge on the San Poil river is being repaired to enable the Illinois Mining Co. to ship ore. A new road from the mine to the main San Poil Valley road has been completed. The power flume to the Keller smelter is under repair. The Wall, Walla mine shaft is down 5 ft. with good copper ore in the bottom.

DURING the first half of 1916 tungsten production of the United States was equivalent to 3290 short tons of concentrate, averaging 60% WO₃ valued at \$917,000, according to the Geological Survey. This estimate is considered to be correct within 10%, rather under than over the true figures. Canada contributed 1505 tons, California, 84 tons, and Nevada, 161 tons. Eight other States reported.



PLAN OF THE THIRD LEVEL (300 FT.), PORCUPINE CROWN MINE, SHOWING GEOLOGY AND INTRICATE BLOCK AND STEP FAULTING TO WHICH THE VEIN HAS BEEN SUBJECTED.

ment for the period January 1 to June 16. From 8 levels, down to 1250 ft., there was hoisted 265,490 tons of ore. The mill treated 263,356 tons, averaging \$8.80 per ton. Mining cost \$2.631 and milling \$9.20c per ton. The mill is soon to be treating 1900 tons daily.

Faulting is much less at 700 and 1000 ft. depth in the McIntyre mine than in the upper workings.

The Tough-Oakes mill is treating 125 tons daily. Twenty-one drills are working underground.

During June the Schumacher yielded 4000 tons of \$5.94 ore, with \$8793 profit. The company has issued its first report, covering October, 1915, to June 30, 1916. The mill treated 30,120 tons, averaging \$5.42 per ton, at a cost of \$4.48, now \$3.87. The profit was \$31,933. Ore reserves are 64,900 tons worth \$6 per ton. A new shaft is to be sunk for extensive exploration.

The West Dome company has decided to sink a 4-compartment shaft in the centre of the property. Considerable work is under way.

The Vipond's June yield was \$37,600 from 10,185 tons of ore, at a cost of \$4.45 per ton. At 500 ft. in the mine the ore-shoot is 160 ft. long.

With a capital of \$2,000,000 the Augarita company has commenced operations in the Dome area of Porcupine. A contract has been let for diamond-drilling. W. G. Barney is manager.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE

For the railroad the Alaskan Engineering Commission has let contracts totaling \$112,000, for grading and ties in the Matanuska, Turnagain Arm, and Talkeetna districts. The last-named centre is reported to be busy, having 300 people engaged in mining and farming.

The territory adjacent to Anchorage is considered to offer inducement to capital for mining enterprises. Some properties are partly and others wholly undeveloped. Fifty-six miles from Anchorage the Crow Creek Mining Co. is employing 42 men at its hydraulic plant on Crow creek, a tributary of Glacier, which empties into Turnagain Arm, above Anchorage.

It is probable that Seward will receive its first 1000 tons of coal from Matanuska this summer, judging by the progress in railway construction.

CHISANA

The Chisana-White River district is described by S. R. Capps in Bulletin 630 of the U. S. Geological Survey. Gold was found on Bonanza creek in 1913. The whole area is strongly glaciated. During the last retreat of the glaciers the melting ice left morainal material throughout the district. Large deposits of outwash gravels were laid down and are still accumulating in the valleys of the glacier-fed streams. Talus, peat, muck, and some volcanic ash, as well as normal stream deposits, make up the post-glacial materials in the areas that are not now receiving glacial and glacio-fluvial deposits. The productive gold-placer gravels of the Chisana district are found within a small area, nearly all the gravels that have been profitably mined lying within a circle 5 miles diameter. Bonanza, Little Eldorado, and Skookum creeks have produced most of the gold mined. The short mining season, comprising only 90 to 100 days, and the remoteness of the district from lines of transportation combine to make mining expensive. Gold has been mined actively, however, and the total production of the district up to and including the year 1914, was probably not far short of \$300,000.

JUKEAU

Gold production of the mines on Douglas island were as following during June:

	Alaska Mexican	Alaska Treadwell	Alaska United
Stamps dropping	120	540	300
Ore crushed, tons	15,820	78,918	44,555
Gold extracted	\$16,672	\$123,061	\$69,929
Yield per ton	\$1.05	\$1.69	\$1.56
Operating expenses	24,392	95,895	70,842
Construction charges	4,406	17,392	10,601
Profit		18,143	
Loss	12,892		12,213
Other income	3,730	11,200	3,730

FAIRBANKS

In his report for the second quarter, the mine inspector, W. T. Maloney, states that the number of underground placer workings in the Fairbanks district has materially decreased, but several rich spots have been struck on many of the creeks, which will bring the average yield up to that of last year. It is expected that the output from the Fairbanks and Tolovana region will exceed that of last year on account of the increased production from Tolovana. Lode operations at Fairbanks

this summer have been confined to antimony mining, and over 1000 tons of ore will be shipped. Of the 10 quartz mills, only one is working, and that intermittently. Several small parties are working on tungsten lodes. Ott and partners shipped 1600 lb. of ore by parcel post in March, but it was delayed in delivery until June, when the price had dropped from \$65 to \$25 per unit.

ARIZONA

GILA COUNTY

On July 26 fire destroyed a considerable portion of the town of Miami.

MARICOPA COUNTY

A winze below the 400-ft. level of the Harqua Hala Bonanza mine, idle for years, has opened ore carrying 4.9% of copper and \$35.20 gold per ton. This property has a large past production.

MOHAVE COUNTY (OATMAN)

(Special Correspondence.)—There is a rumor current of a project to build a railroad into Oatman to connect with the Santa Fe at Topock. At the head of this enterprise is E. R. Hibbard, of Chicago, who is a brother of a Santa Fe official. Also mentioned in connection with the enterprise is Fred Schader, who made the original survey of the Santa Fe company across the desert into Los Angeles. Plans are not complete, but it is stated that the road is to come into Oatman from Topock by the way of the Old Trail. Then it may go north from Oatman, across the Colorado river, through El Dorado canyon, into Searchlight and the north to connect with the Salt Lake route.

Oatman, July 24.

Water from the Tom Reed cyanide-plant residue was recently drunk by 14 burros, resulting in their death. It would be an expensive matter for the company to impound or divert the residue.

YUMA COUNTY

The U. S. Geological Survey has issued as Bulletin 620-C, a report on the gold deposits near Quartzite, by E. L. Jones. This report is based on information obtained by the author while he was classifying the lands in the Colorado River Indian Reservation. The area discussed includes the southern part of the reservation and the region extending eastward from the reservation to the Plomosa mountains. The history of placer mining in this region is rather interesting, and dates back to 1862, when Pauline Weaver was trapping along the Colorado river and at times would stray off into the mountains on prospecting trips for gold. The Indians, with whom he was on friendly terms, gave him some nuggets and, after Weaver had organized a party from Yuma, conducted him to the source of the gold. The party picked up \$8000 in nuggets within a short time, but had to return to Yuma, 150 miles distant, for provisions. A rush from points in southern California and Arizona immediately started for these placers, and within a short time hundreds of miners were prospecting the country around the original location. Water had either to be hauled to the diggings from La Paz or obtained in small quantities from a near-by tank, and it is said that the water hauled from La Paz brought \$5 per gallon during the rush period. It is estimated that \$1,000,000 was recovered in the first year, and as much more in each following year until 1868. Since that time the production probably has been comparatively small.

The gold particles or nuggets ranged in value from 5c. to \$10, although \$20 and \$40 pieces were not uncommon, and the largest piece taken out was valued at \$1160.

CALIFORNIA

BUTTE COUNTY

The Big Blue Lead mine near Bangor, 10 miles from Oroville, has been purchased by F. F. Ford and C. G. Fowler, of San Francisco and Alaska, respectively. The property is an old gravel mine, having a 2500-ft. adit, and has produced a large quantity of gold from the Blue Lead channel. Water for operating will be available in the fall. Other old mines in the district are the Catskill, Grove, Bishop, Raffus, and Turner, all past producers.

PLUMAS COUNTY

For the sum of \$35,000 the Tefft quartz mine at Claremont, 6 miles south of Quincy, has been sold to H. H. Kelly and partners. A 20-ton mill has been ordered.

SHASTA COUNTY

According to Wm. A. Kerr, vice-president of the First National Copper Co., through the 10-year contract which the Balakalala company has with the United States Smelting Co., dividends are at last possible. The first payment will be 25c., and others will follow as earned. The mine is now shipping 9000 tons of ore monthly to the Mammoth smelter, that averages 2.83% copper and \$1 in precious metals. On August 24, 1915, the Balakalala mine resumed shipments after a long idleness. Unable to use its own smelter on account of furnace troubles, this contract was arranged. From the commencement of shipments to the end of the financial year, on June 30 last, the company made net profits of \$175,000 from 76,000 tons of ore. The company spent \$25,000 in making necessary repairs incidental to resumption of operations, and did development equal to 33½c. per ton of ore mined. The management now plans to increase development for which it will set aside 50c. per ton of ore mined. This new work will be confined chiefly to diamond-drill operations.

On July 25 fire did considerable damage (\$50,000) to the town at the Mammoth copper mine, 3 miles from Kennett. The property was temporarily closed. The aerial tram terminal, store-house, machine-shop, and boarding-house were burned. The compressors and motors were saved.

Following the strike for more wages at the Mammoth mine, the Mountain Copper Co.'s men walked out at Keswick on July 25, demanding Mammoth wages.

The demands were granted later on in the week.

The Balakalala Copper Co. voluntarily raised wages equal to those recently granted to the Mammoth employees.

The Michigan claims on Bully hill are to be developed, money being secured by M. E. Dittmar.

TRULINE COUNTY

The Springfield Tunnel & Development Co. has ordered three more machine-drills and will extend its drainage-tunnel, to further develop the good gravel opened recently.

YUBA COUNTY

The B. A. C. mine at Brownville is to resume work on August 1. A new stamp-mill and cyanide plant has been erected.

* COLORADO

Coal mining in Colorado quickly recovered from the effects of the strike in 1913 and 1914, and, according to C. E. Leshner, of the U. S. Geological Survey, the production in 1915 was \$624,980 short tons, valued at \$13,599,264, an increase of 451,421 tons, or 5½% in quantity, as compared with 1914, although the total value in the two years was practically the same. There were no labor disturbances during 1915, and the supply was plentiful. The number of men employed increased

from 10,098 in 1914 and 12,372 in 1915, but the average number of days of work decreased from 243 to 191. The average daily output per man was 3.58 tons and the average yearly output was 698 tons, compared with 3.32 and 809 tons, respectively, in 1914.

The quantity of petroleum marketed from the areas of oil production in Colorado in 1915 amounted to 208,175 bbl., a decrease of 11,298 bbl., or 6%, from the corresponding output in 1914.

CHAFEE COUNTY

In the lower adit of the Mary Murphy mine in the Cave Basin district, 12 to 16 in. of rich copper-silver ore has been cut in formation 10 ft. wide, which is all milling ore worth \$20 per ton. Flotation is successfully applied at this mill.

LAKE COUNTY (LEADVILLE)

Of importance to the district is the cutting of the Pendery fault in the Alright mine on Poverty Flats, lessees encountering granite at a depth of 260 ft., making the fault over 2500 ft. farther north than had been suspected. The Alright, Jason, Coronado, and Northern mines, on the west side of the fault, will have to be deepened considerably before reaching the ore zone which was found at a depth of 260 to 300 ft. in the Hilschle and M. E. C. on the east side. This information was given in Leadville last week by S. Marshall Carlton.

Power-lines are being erected for the Bartlett silver mine in the Sugar Loaf area. Lessees have advanced the adit to a distance of 1600 ft., after which a winze was sunk, power being required to cope with the water, which has always been a trouble.

Pumps are being lowered to the bottom of the Down Town Penrose shaft. The present flow is 2800 gal. per minute.

SAQUACHE COUNTY

The Bonanza district is reported to be busier than for years, several mines that have been idle for a long time are being re-opened. One of these is the Rawleigh, owned by the A. S. & R. Co. The drainage-tunnel is being cleared out. Machinery is arriving for the St. Louis.

TELLER COUNTY (CHIEF CREEK)

During the second quarter of 1916 the Vindicator company shipped 14,877 tons of ore on company and 16,276 tons on lessees' account. Net earnings were \$185,000. The flotation plant below the Golden Cycle ore-house will be completed early in September. Development between No. 12 and 18 levels opened an orebody of better than average grade.

On the 1400-ft. level of the Dillon mine of the Granite company the ore-shoot is 550 ft. long. The June output of the mines on Battle mountain totaled 4000 tons. Lessees continue to do well.

IDAHO

CESTER COUNTY

The Lost Packer mine on Leon creek is employing about 70 men underground, at the mill, and smelter, for a summer campaign. Placer mining on the creek gives work to 60 men.

SHOSHONE COUNTY (COOK MOUNTAIN)

On August 5 the Caledonia Mining Co. of Wallace pays \$5 per share, equal to \$78450, 14½% dividends for 1916 total \$599450.

At the average price of its products for the past 10 years, namely, 45½c. for lead, 5677½c. for zinc, and 5784½c. for silver, the Interstate-Caledonia company at Nye-Moore is expected to be able to earn \$1,000,000 net per annum. The profit in May was \$90,717, with metals above these averages, but the enlarged mill will make an increased output.

The Success Mining Co., with headquarters at Wallace, is remodeling and enlarging its mill situated on Nin Mile canyon, 4 miles from Wallace. It is replacing 8-ton discs

crushers with Garfield rolls and building an additional flotation plant in which will be installed two 12-cell mechanical agitation machines, to be used as roughers and 16 cells as cleaners. The ore, which contains lead, silver, zinc, and magnetite, after a preliminary crushing, is jigged for lead concentrate in 14 jigs, also further concentrated by 17 Wilfley tables. The tailing will be sent to the flotation annex for treatment: the jig product is sent to the rolls to be crushed to 10 mm., then taken by belt-conveyor to a rotary dryer. This product is elevated and the magnetic iron is extracted by the magnets, four of which are installed at present. These machines have proved satisfactory. The capacity of the mill is 300 tons per day. The flotation department is expected to be completed by August 1. The medium to be used is creosote and pine-oil. In order to overcome as far as possible the discomfort and inconvenience caused by the dust incident to operation of the electro-magnetic separation, a settling-chamber is used, built of wood and adjoining the mill. The dust is collected and driven by blowers through 24-in. iron pipes to the settling-chamber, which is fitted with baffle-boards to lessen the air agitation, and hung with wire netting on old jig-screens which act as a settling adjunct. The operation of this settling-chamber in lieu of the bag-house so generally used seems to be nearly as effective and considerably less expensive to construct and operate. The dust saved in this manner is collected and shipped in bags to the smelter.

MISSOURI

JEFFERSON COUNTY

The St. Joseph Lead Co., at Herculanum, has just completed experiments with Dwight-Lloyd sintering-machines and roaster gases. A small Cottrell plant was used for the latter. Various types of electrodes were tried, best results being obtained with No. 12 pipes, 15 ft. long, using No. 10 jack-chains for electrodes. These experiments proved successful, making about 96% lead recovery from the gases. The company contemplates erection of a large 'treater' to deal with approximately 150,000 cu. ft. of gas per minute.

JOPLIN DISTRICT

The 1000-ton per 20 hours mill of Chapman Brothers & Long-acre, north of Cartersville, commenced work last week.

At Commerce, Oklahoma, over \$1000 of damage was done to the power-plant of the King Jack mine when the surface caved to a depth of 50 feet. The mill had a narrow escape, just being on the edge of the hole.

Production of the Missouri-Kansas-Oklahoma region was considerably curtailed last week due to the blading of a 13,000-hp. steam turbine of the Empire District Electric Co. being damaged. Westinghouse mechanics are busy with its repair. At its Riverton plant the company has 3 turbines. The district's output was 4610 tons of blende, 32 tons of calamine, and 918 tons of lead, averaging \$65, \$45, and \$70 per ton, respectively. The total value was \$367,653.

On August 1 the agreed two-year wage increases for 35,000 men in the Missouri, Kansas, Arkansas, and Oklahoma coal mines takes effect. The annual output of the region is 13,000,000 tons. The advances are from 2 to 5c. per ton.

On July 17 a large cave-in took place at 160 ft. depth in the Babcock mine, 4 miles north of Joplin. Four men were imprisoned, and rescue-work was soon under way. They were rescued after 40 hours.

MONTANA

FERGUS COUNTY

(Special Correspondence.)—Lessees at the Cumberland mine in the Judith mountains, George Weiglenda, A. Sellers, Gene Nelson, and Milo Skerro have recently discovered a large body of rich gold ore, 20 tons shipped to the smelter averaging \$115 per ton. Another car of similar quantity is now ready for shipment. The Cumberland was located by Pete Rosso 15

years ago, and is now chiefly owned by James Breen of Spokane, who built a cyanide mill there in 1910. About 35,000 tons of ore was treated, yielding \$275,000, when the known orebodies were exhausted, and in the last few years the mine has only been operated under lease. The vein is usually narrow, but where now being opened is 25 ft. wide. Enough ore is already developed to supply the mill for six months, and as the depth is only 220 ft., it seems probable that the orebody will continue for a considerable distance.

The near-by Spotted Horse now employs 40 men, producing \$12,000 to \$15,000 monthly, mostly from the 100-ton cyanide mill. Concentrate is also produced.—William C. Young has a lease on the McGinness mine, and is employing a small force, sufficient to keep the mill busy about half-time.—Julian Stuart has produced several carloads of lead-zinc ore from the War Eagle. This will be concentrated at the Maginness mill and shipped. The ore contains 7% zinc.—Development at the Gold Acres property at New Year has been resumed under new management after a brief shut-down. The company hopes to start the New Year cyanide mill soon.

The Barnes-King has resumed mining and milling at its North Moccasin property after a shut-down in June for repairs to its power plant. Complete clean-ups were not made from the 1645 tons treated.—The West Kendall property is being carefully examined, and if development now in progress continues favorable a mill will be built.

Drilling for oil is now in progress on a small dome between Swimming Woman and Careless creeks, south of the Big Snowy mountains. In the first well a considerable flow of gas and water was struck at a depth of 700 ft., which damaged the drilling machinery. Repairs have been made, and the well will be sunk much deeper in an effort to find oil.

Lewistown, July 14.

NEVADA

ESMERALDA COUNTY (GOLDFIELD)

Operations are now in progress at 20 properties in this district.—At the Goldfield Consolidated mill the first 500-ton flotation unit is at work.—At a depth of 350 ft. in the Sandstorm-Kendall the cross-cut has passed through the vein from which rich ore was once extracted by lessees.—Exploration at 700 ft. in the Kewanas is yielding promising results.—Work is being resumed at 800 ft. in the Oro.—A re-arrangement of pumps in the St. Ives shaft of the Merges company is to result in important economies for the Atlanta. From the 1750-ft. level the water will be pumped to 1325 ft., through a pipe to the Grizzly Bear shaft of the Goldfield Consolidated, thence by pumps to the surface.

NYE COUNTY (TONOPAH)

Last week the Tonopah mines produced 9217 tons of ore worth \$191,386. In June the Extension made a profit of \$51,726 from \$966 tons, yielding 156,336 oz. of bullion.

During its past year the West End Consolidated Mining Co. treated 56,976 tons of mixed ores, yielding 13,219 oz. of gold and 1,219,968 oz. of silver. Profit from all sources totaled \$270,416.

WHITE PINE COUNTY

For the second quarter of 1916 the Nevada Consolidated pays the county \$49,608 as taxes. During the period there was treated 1,114,821 tons of ore, averaging \$5.861 per ton. The net proceeds were \$3,975,011. Taxes are paid on 80% of the net proceeds.

The U. S. Tungsten Corporation pays \$440 as tax. It milled 2767 tons of ore worth \$38.86 per ton. The profit was \$35,177.

NEW MEXICO

SOCORRO COUNTY

(Special Correspondence.)—The Mogollon Mines Co. has arranged a change in its system of freight delivery from Silver

City. A transfer station, including oil-storage tanks, has been erected at Glenwood, 12 miles from Mogollon, where fuel-oil and other supplies are delivered there by truck, from whence they are hauled over the heavy mountain grades to Mogollon by teams. The other operators are still depending on teams or trucks for the entire trip of 80-odd miles. The company's Last Chance shaft is down 800 ft., and the mill is treating 800 tons weekly.

Material for the mile aerial tram of the Socorro company's Pacific mine is mostly delivered.

Both the Clifton and Eberle mines of the Oaks company are yielding good ore.

Mogollon, July 25.

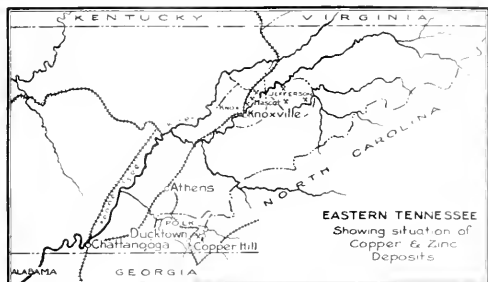
TENNESSEE

KNOX COUNTY

At the Mascot mine of the American Zinc, Lead & Smelting Co. at Granby the mill is being dismantled to make way for a large plant.

POLK COUNTY

The Tennessee Copper Co.'s acid plant at Ducktown is again



in trouble, and acid production is reduced to a low point from the nominal of 750 tons daily. The new plant of 8500 tons monthly capacity is about complete, but has had delays.

UTAH

BEAVER COUNTY

Shipping ore is being developed from 700 to 1000 ft. in the Cedar Talsman in the Star district. The ores mined contain lead, silver, and zinc, about 40,000 tons assaying 10% lead and 14.5% zinc. Such ore is not desired by smelters, so the company is investigating treatment processes.

JUAB COUNTY

The Tintic sampler is handling 400 tons of ore daily. A shift has been suspended on account of light shipments to smelters.

SALT LAKE COUNTY

For the purpose of driving a long drainage and transportation tunnel from Pine canyon on the west side of the Oquirrh range, known as the Bingham West Mountain, to connect with the producing mines of Bingham, the Pine Canyon & Bingham Tunnel Co. has been incorporated with a capital of 1,500,000 shares at \$1 par value. J. B. Moreton is president, Richard Savage vice-president, Homer Benton second vice-president, Louis Levine secretary-treasurer, who, with Henry Jones, Arthur E. Moreton and Ray Van Cott, form the directorate. The work is to be started in the near future. According to those behind the project, the tunnel will pass through the largest patented mineral area in the district, and it is believed that the water met with will be a constant source of revenue to the company. The transportation of ores will also add to the earnings of the company. The haul from the portal will be 2½ miles to the International smelter. The tunnel will be the lowest one in the district. The claims owned by the company

extend east to the apex of the mountain, and are located along two north-east-south-west fissures. From the present tunnel there is 240,000 gal. of water flowing every 24 hours. The company owns 42 claims.

The Utah Ore Sampling Co. is to increase its capital to \$500,000 by issuing 100,000 \$1 shares. The plants are at Midvale, Park City, and Tintic.

WASHINGTON COUNTY

As little has been heard of the Goldstrike district for some time, it is interesting to hear that the Goldstrike Bonanza company has cut a rich gold-silver streak at a depth of 76 ft. on the incline. The shaft is in limestone. Work continues at the Virginia.

WASHINGTON

According to the *Spokane Review* of Spokane the following is a list of new mills in the North-west. Among the new mills already in operation are the following:

Highland-Surprise mine, Pine Creek district, Coeur d'Alene, treating zinc-lead ore, capacity 125 tons of ore daily. Hypocheek mine, Kingston, Idaho, silver-lead ore, 125 tons. Intermountain company, near Iron Mountain, Montana, silver-copper ore, 100 tons. Empire Copper Co., Little North Fork, near Enaville, Idaho, copper ore, 300 tons. Lead & Zinc Mines Co., Metaline, zinc ore, 125 tons. Galena Farm mine, Silverton, B. C., lead-zinc ore, 100 tons. Lucky Jim mine, leased plant at Rosebery, B. C., zinc ore, 60 to 75 tons.

The following plants are under construction and several of them are nearly ready to begin operations:

Ray-Jefferson mine, Carbon creek in the Coeur d'Alene, zinc-lead ore, 400 tons. Snowstorm Consolidated, Troy, Montana, lead-zinc ore, 400 tons. North Star-Triumph mine, near Hailey, Idaho, Federal Mining & Smelting company, zinc-lead ore, 200 tons. Mike Horse mine, near Helena, Montana, Oregon and Montana people, zinc-lead ore, 100 tons. Highland Valley, Ashcroft, B. C., copper ore, 125 tons. Brooklyn mine, Maxville, Montana, zinc-lead ore, 100 tons. Kaslo custom concentrator, to treat Lucky Jim and other zinc ore, 100 tons. Florence Silver company, Ainsworth, B. C., silver-lead ore, 200 tons. Deer Trail company, Cedar canyon, Stevens county, Washington, silver-lead ore, 100 tons. Idaho Continental company, near Port Hill, Idaho, lead-silver ore, 300 tons.

Among the plants whose construction has been authorized but not yet begun are:

Consolidated Interstate-Callahan company, Enaville, Idaho, zinc ore, 1200 tons. Tamarack & Custer company, Wallace, Idaho, silver-lead ore, 250 tons. Constitution company, Pine creek, Coeur d'Alene, zinc-lead ore, 100 tons.

CANADA

BRITISH COLUMBIA

According to reports received by the Mines Department the present rate of mineral production in this Province is over \$8,000,000, against \$23,000,000 in the record year, 1912. Coal mining especially is on a greatly increased scale.

Ore received at the T. A. L. smelter continue to grow, that for the third week in July 1916, 103 tons, a considerable increase.

It was rumored that as the Standard Silver-lead company, at Silverton marketed its product through Bee, Sandhime & Co. of New York, the Standard company would be affected by the firm's being blocked by England. This is not so, and the Standard can continue to sell as usual.

MEXICO

According to S. W. Felt of the U. S. & R. Co., mining and other conditions in this country are very different with no apparent relief in sight. Nothing is being done in the way of mining or ore reduction at the company's plants in Mexico at present. They have been turned over to the true Mexican men.

ployees. Heretofore the company has been sending food supplies to those parts of the country where the plants are situated, not only for employees but for all living in the vicinity of the plants. This has now become practically impossible due to the inability of the Carranza officials to guarantee the arrival of such shipments.

KOREA

The Seoul Mining Co., operating the Suan concession in Whang Hai province, Chosen, reports the following results for June:

Ore treated, tons	14,555
Mills ran, days, average	22
Bullion	\$ 25,105
Concentrates	92,552

Total recovery	\$117,657
Expenses	57,500

Operating profit

June was low in milling days, principally because of changes made at the Holkol 40-stamp mill. Beginning with June 10 half this mill only was run on ore from the Suan mine, which the mill has previously treated exclusively. The other half of the mill, after making some changes for the purpose, treated ore from the adjacent huge low-grade deposit of gold, copper, and tungsten, in order to determine practically the best method of extraction. This deposit is known as the Sotcarie. Half the Holkol mill was worked for 25 days on Suan ore and half for 19 days on Sotcarie ore, or an average of 22 days. Also owing to changes, the mill at Tul Mi Chung mine ran only a little under 23 days on its ore, hence the smaller results shown for June than for a few months previously. Extraction on the Suan ore was remarkably good, 91.5% gold and 86.5% copper. From 2150 tons of Sotcarie ore 8252 lb. of tungsten concentrate was recovered, presumably of an expected 50 to 60% grade, this besides a fair recovery of gold and copper contents. For the first milling this is considered satisfactory. Milling capacity at Tul Mi Chung is being rapidly raised, the record being 453 tons on June 6. They are not now amalgamating at Tul Mi Chung.

THE AMALGAMATED ZINC (DE BAVAY'S), LIMITED, in the half-year ended December 31, 1915 states that the flotation plant at Broken Hill, Australia, treated 161,943 tons of purchased tailing, yielding 48,195 tons of concentrate assaying 19.1% zinc, 5.8% lead, and 7.9 oz. silver; also 710 tons of concentrate containing 57% lead, 11.1% zinc, and 48.2 oz. silver per ton. There was shipped 65,934 tons of concentrate, part of which was from the previous period. Sales realized £385,552, of which £159,823 was spent in operation, payment of tailing, etc. The profit was £168,078. No. 16 dividend, of 72 cents per share, was paid on January 16, 1916, absorbing £75,000, making £550,000 to date.

The general manager, H. W. Gepp, is still in America in connection with sales of concentrate, and investigating electrolytic zinc processes.

Obituary

MATTHEW HENRY WALKER, a prominent citizen of Utah, who, with his brothers, was a pioneer in mining in that State, died from cancer at Salt Lake City, on July 28. He is survived by a widow, a son, and a daughter. Mr. Walker was connected with many mining companies, and the Walker Brothers bank in Salt Lake City is a well-known institution. He was a man of charitable instincts, and did many acts of kindness in a quiet way.

THE EDITOR would be grateful for photographic prints suitable for reproduction in this paper.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

W. B. DENNIS has gone to New York.

E. A. JULIAN was in Anador county this week.

J. R. TYRRELL of Toronto is in British Columbia.

A. ROOS is mining copper near Organ, New Mexico.

LOUIS A. DECOTO is on his way back from Columbia.

DAVID KEITH of Salt Lake City was in town last week.

HERBERT C. WOOLMER has arrived in London from Moscow.

WILLIAM BRADEN has returned to New York from Chile.

WALDEMAR LINDGREN was in the Yellowstone Park during July.

JOHN D. KIRCHEN of Tonopah was in San Francisco this week.

V. F. STANLEY LOW has returned to London from South Africa.

E. H. COOK has returned to Los Angeles from Culiacan, Mexico.

GEORGE S. EMBURY has returned to Berkeley from Pachuca, Mexico.

O. B. PERRY has returned to New York from the Yukon goldfields.

FRED S. PORTER is now with the Canadian Klondyke Co. at Dawson.

CHARLES JANIN is on his way back from Dawson, Yukon Territory.

ARTHUR W. STEVENS has returned from Colorado to Piedmont, California.

W. A. CARLYLE has left London for Toronto, which he will make headquarters.

E. M. HAUG has joined the engineering staff of the Tonopah Extension Mining Company.

G. H. WOHLHAUPTER of Magna, Utah, is taking a holiday at Houghton, Michigan.

F. C. RORCK of Michican is now with the Consolidated Arizona Copper Co. at Humboldt.

L. G. E. BIGNELL has joined the sales department of the Colorado Iron Works Co. at Denver.

WILLET G. MILLER has been to Mount Lyell and Broken Hill, proceeding from Melbourne to New Caledonia on July 6.

HENRY G. WALKER has arrived here from Shanghai, having inspected mines in the Chinese province of Chekiang.

JOSEPH W. RICHARDS, professor of metallurgy in Lehigh University, was in Butte last week, on his way to the Pacific Coast.

ROBERT M. RAYMOND, professor of mining in Columbia University, has been in Michigan and is now at Butte. He is expected here next week.

ERNEST MARQUARD, who has been in China for some time, has joined the Associated Geological Engineers of Pittsburg, and is now in Oklahoma.

E. T. MELLOR has resigned from the Geological Survey of the Transvaal to accept a position as consulting geologist with the Rand Mines and Central Mining companies.

JNO. M. BAKER and HAMILTON W. BAKER have resigned as general manager and mine superintendent, respectively, of the Baker Mines Co. of Oregon, and are now at Denver.

MORRIS WEBBER has returned to the practice of his profession at New York. For the larger part of two years he served as an artillery officer in the British army, in France, Gallipoli, and Bulgaria, being twice wounded and finally discharged with honor.

THE METAL MARKET

METAL PRICES

San Francisco, August 1.

Antimony, cents per pound	15
Electrolytic copper, cents per pound	27.50
Pig lead, cents per pound	10.00-11.75
Platinum: soft metal, per ounce	\$65
Platinum: hard metal, 100% iridium, per ounce	\$69
Quicksilver: per flask of 75 lb.	\$89
Spelter, cents per pound	11
Tin, cents per pound	11
Zinc-dust, cents per pound	20

Rich deposits of platinum are reported to have been discovered recently on the River Vilna, near Irkutsk, in Siberia.

ORE PRICES

San Francisco, August 1.

Antimony: 50% product, per unit (1% or 20 lb.)	\$9.75
Chrome: 40% and over, f.o.b. cars California, per ton	13.00-16.00
Manganese: 50% product, f.o.b. cars California, ton	12.00-16.00
Magnesium: crude, per ton	7.00-9.00
Molybdenum: 50% and over, per pound	0.50-1.15
Tungsten: 60% WO ₃ per unit	20.00

The tungsten situation at Boulder, Colorado, is considered by J. G. Clark, of the Boulder Tungsten Production Co., to be better. His company is negotiating for a year's ore at \$25 per unit.

New York, July 26.

Antimony: A few sales of spot material is reported at \$1.25 to \$1.50 per unit.

Tungsten: French consumers continue to negotiate, but the buyers do not want to meet the market. The nominal quotation is \$27 to \$30 per unit. It is reported that production has been curtailed in several directions. It is a significant fact that high-speed tool-steel was scarce and eagerly sought a few months ago, while today the makers are looking for business, and likewise the sellers of ferro-tungsten.

EASTERN METAL MARKET

(By wire from New York.)

August 1.—Prompt copper is scarce; lead is stagnant, spelter is dull and easy.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
July 26	25.00
" 27	25.50
" 28	25.75
" 29	26.00
" 30 Sunday	25.12
" 31	26.00
AUG. 1	26.25

Monthly averages

1914	1915	1916
Jan. 14.21	12.69	24.50
Feb. 14.46	13.58	26.62
Mar. 14.11	13.80	26.65
Apr. 14.19	16.64	28.02
May 13.97	18.11	29.02
June 13.69	19.75	27.47

The Ohio Copper Mining Co. of Utah is to be re-organized with a capital of \$5,000,000 new securities. The Bingham Central Railway is included. Foreclosure takes place on August 1. June outputs include 1,500,000 lb. by Arizona Copper, and 4,011,361 lb. by Granby Consolidated.

Greene-Cannara is operating on the basis of 5,000,000 lb. per month. A dividend of \$2 per share is payable on August 25. Utah Metal & Tunnel Co. is paying its initial dividend of 25¢ per share, on August 15. This amounts to \$225,000.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
July 26	63.25
" 27	63.75
" 28	63.62
" 29	63.50
" 30 Sunday	64.12
" 31	64.00
AUG. 1	64.00

1914	1915	1916
Jan. 13.26	19.09	25.66
Feb. 12.34	17.27	26.11
Mar. 12.92	17.69	26.11
Apr. 11.10	17.90	26.11
May 11.75	18.88	26.11
June 12.75	20.67	26.11

Monthly averages

1914	1915	1916
Jan. 55.58	48.82	56.75
Feb. 53.53	48.45	56.74
Mar. 58.01	50.61	57.89
Apr. 58.52	50.25	61.57
May 58.21	49.87	74.27
June 55.43	49.03	65.04

The market has continued to be spotted. Prices have been a little stronger. The London market now shows 10,000,000 oz., and the fact, while not very certain, of weak.

For a large proportion of the world's supply of silver come into the market. As rather depressed and prices, especially such as from the Indian Bazaars. The demand for the metal is the market is a certain amount of selling to the bank dealing with China, which, together with a small supply of America, has met the demand for silver in demand for silver, urgent and continuous.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
July 26	6.20
" 27	6.20
" 28	6.20
" 29	6.20
" 30 Sunday	6.20
" 31	6.20
AUG. 1	6.20

Monthly averages

1914	1915	1916
Jan. 4.11	3.72	5.95
Feb. 4.02	3.83	6.23
Mar. 3.94	4.04	7.26
Apr. 3.86	4.21	7.70
May 3.90	4.24	7.58
June 3.90	5.75	6.88

On August 4 the Banker Hill & Sullivan company paid two dividends of \$81.75 each. The total to date is \$1,927.50.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
July 26	10.50
" 27	10.25
" 28	10.25
" 29	10.00
" 30 Sunday	10.00
" 31	10.00
AUG. 1	9.75

Monthly averages

1914	1915	1916
Jan. 5.14	6.30	18.21
Feb. 5.22	9.05	19.99
Mar. 5.12	8.40	18.40
Apr. 4.98	9.73	18.62
May 4.91	17.03	16.91
June 4.84	22.20	12.85

QUICKSILVER

The primary market for quicksilver at San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices in dollars per flask of 75 pounds:

Date	Week ending
July 26	8.00
" 27	8.00
" 28	8.00
" 29	8.00
" 30 Sunday	8.00
" 31	8.00
AUG. 1	8.00

Monthly averages

1914	1915	1916
Jan. 39.25	51.90	50.00
Feb. 39.00	60.00	50.00
Mar. 39.00	78.00	50.00
Apr. 38.50	77.00	50.00
May 39.00	75.00	50.00
June 38.00	90.00	50.00

TIN

Prices in New York, in cents per pound.

Date	Week ending
July 26	19.41
" 27	19.41
" 28	19.41
" 29	19.41
" 30 Sunday	19.41
" 31	19.41
AUG. 1	19.41

Monthly averages

1914	1915	1916
Jan. 19.41	19.41	19.41
Feb. 19.41	19.41	19.41
Mar. 19.41	19.41	19.41
Apr. 19.41	19.41	19.41
May 19.41	19.41	19.41
June 19.41	19.41	19.41

Eastern Metal Market

New York, July 26.

Copper, zinc, and tin present a better aspect, and the entire market has not the forlorn appearance it had a week or two ago.

Copper has a better tone, and it is asserted that good buying will follow a reduction of a few points in producers' quotations. The metal in second-hands is gradually being absorbed.

In the past 10 days export buying of zinc has been heavy, and quotations have advanced both here and in London.

Future deliveries, and metal afloat, have been fairly active in the tin market, and the tone is the best for many months.

Lead continues to drag in the absence of War business, and the trade says that new sales can be expected only at lower prices. Buying probably would start at 6c., New York.

Antimony continues dull.

Aluminum is unchanged at 58 to 60 cents.

An idea of the extent to which steel has been in demand is afforded by the fact that the earnings of the United States Steel Corporation in the second quarter of this year amounted to \$1,000,000. In many products, particularly steel plates, the demand is unabated. Following the decline in zinc, the makers of galvanized iron and steel pipe have reduced their prices \$10 per ton. Sheets are easier also. Though not officially confirmed it is known that orders for shells valued at approximately \$60,000,000 are to be placed in this country by Great Britain's fiscal agent, J. P. Morgan & Co. Sizes ranging from 6 to 12 in. will be called for. Already prospective contractors are inquiring for the large lathes and other machine-tools needed to execute such work.

ZINC

The improvement noted last week, which was started by purchasing on the part of domestic galvanizers, at prices somewhat under 9c. (for spot), was followed by an excellent demand for foreign consumers. A large quantity of zinc has been sold for export, at prices ranging from 9c. New York, for spot, to 10.50c., the quotation of yesterday (July 25). It is not thought that the export-demand is entirely satisfied. The London market is strong; it was quoted yesterday at £60 against £18 a week ago, an advance of £12. It is not considered that zinc will again go to the high levels of early this year, when at one time 21.50c., was quoted, but the opinion is pretty general that it will not average much under 10 to 12c., from this time on. Of course, this is all more or less guesswork, but it does indicate what the trade would like to see. Domestic consumers assert they should get the metal at about 8c., spot delivery, but it is pointed out that, considering the higher cost of production now prevailing, this price would really be about equal to 5c. The galvanizers, though they bought heavily a few days ago, should do more, inasmuch as they are operating not to exceed 50% of capacity, and a few only 25 to 40%. The galvanized-sheet market is very dull, consumers waiting for lower prices. Now that zinc has taken a turn upward it is questionable if they will get them. Not only is the cost of zinc involved, there also is the high price of sheet bars from which the sheets are rolled. Prices for zinc, prevailing yesterday, were 10.50c., New York, for spot, 10.25c. for August, and 10c. for September. Exports in 26 days were large, amounting to 5648 tons. Sheet zinc is unchanged at 15c. for b. mill, carload lots, 8% off for cash.

LEAD

The market has continued dull and drooping. Today (July 26), lead can be obtained at 6.20c. New York, and 6c. St. Louis, but there is little or no business despite the fact that some large consumers are known to be disposed to buy. It can be reiterated that present prices cannot be maintained

unless there develops a large volume of export business. The A. S. & R. Co. continues to quote 6.50c., New York, and 6.42½c., St. Louis. It is believed that 6c. New York would start some action. Some authorities say that stocks are not accumulating, but others, equally as authoritative, say that production is exceeding consumption. The London market is slightly lower than a week ago, at £28 5s. (July 25). Exports, to the 26th, totaled 2126 tons.

COPPER

While the quotation for spot lots of electrolytic held by second-hands, and to some extent by the smaller producers, has been practically stationary at 25c., cash, New York, the market has a firmer tone and a more hopeful aspect generally. Inquiries have been more numerous, the re-sale metal is gradually being absorbed, and there is a pretty well-defined feeling that the big producers are trying to 'local' a level which would stir consumers to action for the later deliveries. It is recognized that 29.25c.—the public quotation of the large producers—is a nominal price that will attract no buyers. It is commonly expressed by the trade that somewhere around 24c. would be likely to win business. As already said, inquiry has been better in the past two or three days and re-sale prices have become firmer, and the holders are not over-anxious to sell. Some of them are asking up to 26c. for July delivery, and 25c. for September. Lake copper is nominal around 25.25c. cash, for spot delivery. The London market also shows renewed strength, although electrolytic there is unchanged at £122. Exports from July 1 to 26 totaled 28,917 tons. The export demand for spelter has been good in the past 10 days, and it has been expected that some of this betterment would be imparted to copper. The following comparative statement, prepared by Secretary Mayer of the Metal Exchange shows copper exports from the United States in six months of this year, compared with those of the same period in 1915, in long tons:

	1916	1915
United Kingdom	31,732	47,109
France	76,127	19,148
Holland	1,138	457
Italy	23,723	23,965
Denmark	898	1,050
Norway and Sweden	7,223	10,567
Russia	5,053	3,151
China and Japan	71	49
Sundries	1,978	1,031
Total	147,943	136,527

TIN

The week has been a fairly good one, and for the first time in many months the market has shown strength. The activity began on July 19 with purchasing of futures and tin afloat, followed again July 25 by another flurry for the same positions. Extensive sales were made on the basis of 38c. for spot Straits. More would have been done had not London advanced too rapidly. The London market for spot Straits yesterday was £167 against £164 10s. a week ago. There was afloat yesterday 2396 tons, and in the month 2955 tons arrived.

ANTIMONY

A few inquiries are before the market but they are not sufficient to change the trend of prices, and the metal is dull at 13.50 to 14c., duty paid. Antimony in bond has been sold at 11c. Needle antimony is nominally quoted at 9c. per lb., forward delivery.

Company Reports

TONOPAH EXTENSION MINING CO.

This Nevada company had a highly profitable period during the year ended March 31, 1916, when the net revenue was \$613,418, and the Murray vein was opened for a considerable size at a depth of 1540 ft. Reserves indicate at least 15 years' ore supply. According to the general manager, John G. Kirchen, development covered 13,967 ft., making 115,218 ft. to date.

The mill, which is being enlarged, treated 91,581 tons of ore, averaging 0.24 oz. gold and 24.93 oz. silver per ton, a decrease of metal-content. The extraction was 92.39%.

There was sold 20,575 oz. of gold and 2,106,518 oz. of silver for \$1,532,910. Costs totaled \$10,965 per ton, a decrease of 51.1c. Mining was \$4,614, treatment, \$4,478, and freight, refining, etc., 5.91c. Dividends absorbed \$306,613.

OURO PRETO GOLD MINES OF BRAZIL.

This English company operates in the province of Minas Geraes, Brazil. The interesting 72-page report of the superintendent, A. J. Bensusan, deals with the year 1915. Development in the Passagem mine totaled 5375 ft., a good increase. The secondary No. 3 shaft is down 4641 ft. on the incline. Some promising results were obtained, but no large orebodies were added to the reserves, which amount to 74,705 tons, a decrease of 37,973 tons. The 80-stamp mill crushed 85,400 tons of ore with 91.41% recovery; the cyanide works treated 6736 tons of concentrate with 88.71%, 63,206 tons of sand with 74.01%, and 11,630 tons of slime with 81.96% extraction. Sand treatment cost 14c., and slime 71c. per ton of material. Gold from all sources realized £120,592 (\$580,000), equal to \$6.78 per ton. Expenses in Brazil were \$6.10 per ton. The profit was £9545. Preference shareholders were paid £1221, or 10% per annum. The net balance is £5137.

The report includes figures in metres, kilometres, grams, milreis, pounds, shillings, and pence.

ST. JOHN DEL REY MINING CO.

The 68-page report of the superintendent, G. Chalmers, for the 85th annual meeting of this English company operating the Morro Velho mine in Brazil, contains a mass of detail from which the following is abstracted:

Horizon (level) 19, a vertical depth of 5526 ft. below the surface, was opened by a winze from No. 18 level, a distance of 304 ft. Good ore was cut at 242 ft. down. Development of the lode on No. 19 was quite satisfactory. Ore reserves are estimated at 788,439 tons, equal to 4 years for the mill. Ventilation as usual occupied considerable attention, the temperature on No. 19 being 107° F. The fan worked well throughout the period. There were 6 fatal accidents in the mine. There was no shortage of labor.

The mill crushed and treated 192,500 tons of ore, yielding 109,555 oz. of gold and silver bullion, equal to \$11.63 per ton. Several improvements were made to the plant.

The revenue was £479,236, less £284,004 for all charges and £27,156 for Brazilian State and Federal duties, etc. The working cost, with development, was \$6.94 per ton. Dividends paid amounted to £11,750 on preferred, and £54,627 on ordinary shares, including taxes. Investments were valued at £202,991 on February 29, 1916.

On account of rapid cutting of trees re-forestation has been studied, and many trees planted. Further additions are proposed for hydro-electric power. The average cost is 2.918 cents per hp.-day. The 8-kilometre electric tram from the mine to Raposos on the Central Railway worked well. The medical department attended to 24,655 patients.

Recent Publications

VOLCANIC HISTORY OF LASSIN PEAK. By J. S. DUFF. In print from *Science*, May 26, 1916. P. 7. Illustrated.

MARKETS FOR MACHINERY AND MACHINE TOOLS IN AMERICA. By J. A. MERRILL. P. 64. Illustrated. Special Agents Series No. 116. Department of Commerce, Washington, D. C. 1916.

HANDBOOK AND DESCRIPTIVE CATALOGUE OF THE METALLIC COLLECTIONS IN THE UNITED STATES NATIONAL MUSEUM. By G. P. MERRILL. Bulletin 94. P. 207. Illustrated. Washington, D. C., 1916.

USEFUL MINERALS. HOW TO FIND AND KNOW THEM. By A. J. BURDICK. P. 42. Gateway Publishing Co., Beaumont, California. Price 50c. A handy little book for prospectors and others.

OIL-FLOTATION PROCESSES. Patents relating to R. S. LEWIS and O. C. RALSTON. P. 56. Index. Bulletin 8 of Utah Engineering Experiment Station of University of Utah, in cooperation with the U. S. Bureau of Mines.

THE IDEAL MORTAR FOR BRICK MASONRY. The Hydrated Lime Bureau of the National Lime Manufacturers Association, Pittsburgh. P. 32. Ill. index. Discusses experiments made with various mortars. One composed of 50 lb. cement, 20 lb. hydrated lime, and 300 lb. sand gave greater strength than several containing a greater proportion of cement.

HEAVY TIMBER MILL CONSTRUCTION BUILDINGS. By C. E. PAUL. P. 66. Ill. index. Engineering Bureau, National Lumber Manufacturers Association, Chicago. Mill construction is here used in the restricted sense of timber construction under special recognized standards. The result should be a structure that is in many respects more fire-resisting than a poorly constructed steel building. The pamphlet discusses the design and construction of such buildings and gives a number of useful tables. While issued by an association of lumber manufacturers with the object of increasing the use of their product, the pamphlet can hardly be called trade literature in the ordinary and somewhat derogatory sense of the term.

THE THEORY AND PRACTICE OF MODERN FRAMING STRUCTURES. By J. B. JOHNSON, C. W. BRYAN, and F. E. TURNER. Ninth edition, rewritten by F. E. TURNER and W. S. KINNE. Part III. Design. P. 479. Ill. index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, \$4.

The latest edition of this standard work has been rewritten by one of the surviving authors in collaboration with W. S. KINNE. The general arrangement and the topics covered are, however, similar to the old work. The subject of columns has been treated at considerable length, both from the standpoint of experiment and of theory. Second stresses are considered with special reference to their influence upon design. The analysis of girder stresses is especially complete. The chapters on highway bridges, foot bridges, and mill construction are comparatively brief. A complete list of chapter headings is as follows: *Stresses in Structures, Working Conditions, Compression Members, Combined Tension and Bending Stresses, Riveted Joints, Plate Girders, Framed Structures, Design of a Pin Connected Railway Bridge, Riveted Truss Design of a Riveted Highway Bridge, and Steel Railway Bridges.* The appendices contain general information on steel railway bridges, a list of standard and non-standard unsymmetrical beams.

Industrial Notes

Information supplied by the manufacturers.

Beyer Barometric Condenser

The Ingersoll-Rand Company of 11 Broadway, New York, is now offering to the trade complete steam condensing plants for all service conditions. This equipment includes the Beyer barometric condenser, for which the company has secured the patent rights, Imperial duplex and Ingersoll-Rogler straight-line, reciprocating, dry vacuum-pumps and, where required, Cameron simplex and centrifugal pumps.

The Beyer condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above, and the air removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle-plates assisting the water to absorb

and vapor at a comparatively low temperature, a distinct advantage as the reduced volume saves in vacuum pumpage horse-power. The steam inlet is of large diameter to secure low velocity, and is hooded in such a way as to discharge the steam into the centre of the condensing vessel. The air removal opening is also of ample area and is protected by a self-draining baffle and trap. This, it is said, positively prevents water being carried over into the vacuum pump. The hot waste water is discharged through the self-draining tail-pipe. This pipe straddles the hot-well and rigidly supports the condenser. The Imperial and Ingersoll-Rogler vacuum-pumps are of the manufacturer's standard type. When a water-pump is required to elevate cooling water to the condenser head, Cameron pumps are provided. These may be either reciprocating or centrifugal as desired. The Ingersoll-Rand Co., however, emphasizes the fact that, where the level of the cold-well is of sufficient height above the hot-well, the condenser will lift its own cooling water, dispensing entirely with a water-pump.

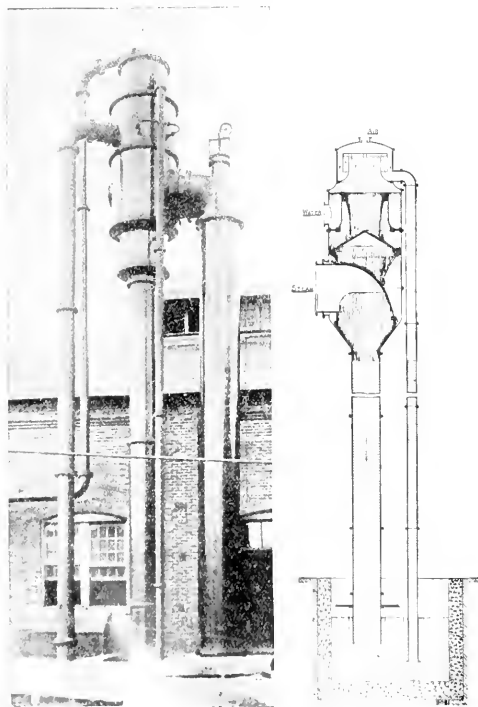
The manufacturer emphasizes the point that the vacuum and water pumps, being independently operated, can be regulated to suit varying water temperatures and conditions.

Commercial Paragraphs

Vulcan steel-frame electric hoists for mines are described by the HENDRIE & BOLTHOFF MANUFACTURING & SUPPLY Co. of Denver in an attractively arranged booklet. The 250-hp. machine has a capacity of 3700 ft. of rope.

Cemented gold-bearing gravel is difficult to treat and save the precious metal, so some method of disintegrating the gravel is necessary whereby the large boulders and pebbles, which are barren, are simply free, not crushed, and discarded, while the sand, etc., is available for washing. Many systems have been tried with varying success. The G. W. Price Pump & Engine Co. of San Francisco claims to have devised a cement-gravel mill that will give the desired result. The machine consists of a hexagonal drum, in which the gravel is disintegrated by rubbing against itself, and cleaning the boulders of adhering material with streams of water. The fine material passes through screens and sluices, where the gold is caught. The large stones are automatically discharged. A 6-ft. mill will treat from 6 to 15 tons per hour, using 12 hp., at a cost of 5.6 to 9.4 cents per ton, depending on circumstances.

If improvements are to be made in mining methods, the E. I. DU PONT DE NEMOURS & Co. of Wilmington, Delaware, considers that one should install and adopt the electric method of firing explosives instead of the old method of fuse and blasting cap. In most of the modern and up-to-date coal mines electric firing and the use of permissible explosives have been adopted. Few mines exist in which conditions could not be made more safe, and the protection of the property enhanced by the use of permissible explosives and electric firing. The U. S. Bureau of Mines reports that fatalities during 1903, directly traceable to explosives, were 0.339 per 1000 men employed; in 1914, 0.096 per 1000, a reduction of 72%. Much of the credit for this remarkable improvement is due to the use of permissible explosives and electric firing. When explosives are detonated electrically, the maximum execution is always assured. The blast cannot occur until the miner desires it and when everyone is in a safe place. As many holes can be fired at one time as desired, so that it is possible to use less explosives per ton of coal or ore than when fired by fuse and blasting caps. The cost of installation is low; a blasting-machine suitable for use in coal mines costs about \$10 and will last for years if properly cared for, while electric blasting caps cost little if any more than ordinary fuse and caps, and the cost of leading wire is small. The advantages and benefits gained greatly outweigh the small first cost of installation.



SECTION AND PHOTO OF ACTUAL INSTALLATION OF BEYER BAROMETRIC CONDENSER.

to its full capacity the latent heat of the steam. The non-condensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. It is also to be noted that ample opportunity is given for the removal of the air-content of the water before it mixes with the steam. This, the manufacturer points out, not only facilitates the mixing process, but permits the removal of air

EDITORIAL

T. A. RICKARD, Editor

TWO fellowships, of \$500 each, in metallurgical research have been established in the University of Idaho by the mining men of that State. This is an example to our friends in other mining regions.

SAGE-BRUSH is one of those plentiful products of nature for which it would be desirable to find industrial use; our readers will therefore be interested to know that a flotation-oil is being distilled from sage-brush, and that experiments made at the School of Mines at Reno, Nevada, indicate that it is twice as effective per volume as an equal quantity of pine-oil.

DURING July several lives were lost in California by explosions attributed to oxy-acetylene apparatus. Enough evidence has been gathered by the Industrial Accident Commission to warn users that tanks containing oxygen made by the electrolytic method are likely to contain hydrogen, forming a dangerous mixture. Investigations are being continued.

HOW metal is consumed at the battle-front is suggested by figures given by Hilaire Belloc. According to him it is stated at Berlin that in taking Hill 304, commanding the approach to Verdun, 37 trainloads of 40 cars each of shells were used. He also states that the actual cost of the eight or ten million shells used at Verdun alone during the past five months of continuous fighting has been \$300,000,000.

THAT the mines exploiting disseminated copper have increased their production greatly is indicated by a comparison between the June output this year with that of June 1913.

	June 1916 Lb.	June 1913 Lb.
Utah Copper	17,877,432	11,637,949
Nevada Con.	8,651,772	6,344,863
Ray	6,598,594	4,392,612
Chino	7,243,618	3,876,523

These four comprise the so-called Jackling group. The other mines of the 'porphyry' type are increasing their production at a similar rate.

ST. JOHN DEL REY, the deepest metal mine in the world continues to do well. The bottom remains at 5826 feet vertically below the surface. The company has just issued its 85th annual report, from which it can be seen that the enterprise is of respectable age. During the year ended on February 29, 1916, the mine produced 192,500 tons of ore yielding \$2,280,644 worth of gold, or

\$11.84 per ton, earning a profit of \$771,518. Owing to the step-like succession of shafts and levels, the poor ventilation is an obstacle to deeper exploration. The temperature at the bottom is 104° F. Mr. George Chalmers, the veteran manager, intends to use a cooling and drying equipment for improving the air, expecting thereby to render conditions more comfortable for the miners underground.

CALUMET & HECLA is receiving honorable mention in the press in consequence of its semi-centenary. The changes in the yield and cost per ton of ore afford a good text for comment. At one time the yield of copper was 100 pounds per ton of ore; this declined to 20 pounds. Meanwhile the cost has been reduced from \$10 to \$2 per ton of ore, otherwise the mine would have been closed-down long ago. The Calumet & Hecla has done well, but it would have done much better if it had not stuck so long to a policy of secrecy in regard to its technical operations. Secrecy usually goes with unprogressiveness. The man or company that declines to give information is the one not to receive it. Our own observation proves to us that the management that refuses access to its mine, mill, or smelter is usually behind hand in its technical work. The three notoriously secretive mining companies, the Rio Tinto, Homestake, and Calumet & Hecla have gained nothing from such a policy.

MAGNESITE has depreciated suddenly. The principal producer of this mineral product in Tulare county, a company that has been contributing 80% of the Californian output, has been unable to renew its contracts with the American Refractories Company, the General Refractories Company, and other big consumers. The contracts were to have been renewed in July. Another company, also operating near Porterville, finds itself unable to find a market. The reason is that the product has been allowed to deteriorate, by increase of silica, to such a point that it became unsaleable. In one case an effort has been made to raise the average by buying higher-grade deposits and mixing their produce with the main supply, but even this improvement has proved unavailing in face of the unexpected importation of 20,000 tons of Greek magnesite, knocking the bottom out of the domestic market. Of course, prices have been abnormal recently. Crude magnesite used to be delivered at West Berkeley for \$2.50 per ton, allowing \$1.50 for mining and \$1 for freight. Calaine magnesite used to sell for \$15 in the East. Recently consumers at Pittsburgh and Joliet had to pay something like \$10 for calaine, the price for crude here being \$10. That is why

the European supply has been drawn upon, as was done when quicksilver was kited to an impossible price.

Then and Now

In this issue we discuss the difference in economic conditions governing mining on the Mother Lode in California as compared with thirty years ago. A similar comparison might be made for any other Western mining district, and, with minor differences, it would be equally suggestive. It happens that 1869 just includes the use of nitro-glycerine, which was first introduced, at the Hoosac tunnel, in 1867. The discovery of an absorbent for nitro-glycerine and the preparation of a neutral product, both of which we owe to Nobel, marked a distinct epoch in mining. Previously, owing to its excess of oxygen, which renders this explosive so effective without the aid of extraneous oxygen, it had been most unsafe to handle and had been the cause of a number of accidents almost ludicrous in their unexpectedness. Soon afterward came the power-drill, the Burleigh machine being used at the Hoosac tunnel in 1866 and at the Georgetown mines, Colorado, in 1870. It was gradually modified, increasing in strength and lightness until now it is handled by one man and employed advantageously even in a narrow stope. Where formerly a miner would do 6 to 8 feet of drill-holes in a shift and break $1\frac{1}{2}$ tons of ore, now with a machine-drill one man drills 35 feet of holes and breaks 7 tons per shift. Even in later years the improvement is remarkable. In the North Star mine, at Grass Valley, it required 80 men in the stopes to supply 40 stamps; now 20 men will make the same output of ore. Another example, among many, of the help given by machinery is the tool-sharpener. This simple device will cost \$1200 and last four years, so that allowing 5% on the original cost, it will cost \$1440 in four years. It does the work of six men, three pairs each consisting of a sharpener and his helper, at a cost of \$5.75 per pair, or \$17.25 per day or \$5175 per annum or \$20,700 in four years. The power required for a sharpener is only 50,000 cubic feet of air at 24 cents per 1000, or about \$1 per shift. Using this machine a pair of men will sharpen and temper 300 to 350 drills per shift; by hand a pair of men will sharpen 80 to 175 drills per shift. Again, to make a wider comparison: The labor of 40 men will cost \$36,000 per annum. Machinery that would do the work of 40 men may cost \$40,000; it will last 10 years and represent a cost, with interest, of \$60,000. But in 10 years the 40 men will have received \$360,000 in wages. This example would show a saving of \$200,000, less the cost of power, for the machinery. Apart from the actual saving, the use of machinery facilitates large-scale operations that not only lower the cost per ton but diminish the effect of vagaries in the richness and distribution of the ore. Extensive development carries a large mine through bad times, which compel a small mine either to shut-down or change ownership at intervals.

Speed of exploratory work is an important factor, de-

creasing the ratio of overhead expense and enabling new reserves to be opened up at a rate commensurate with the increased capacity of the mill. Where two or three feet was made in a cross-cut by hand, it is now practicable to advance 7 feet per shift by use of a power-drill. The speed of driving on a vein is fully twice what it was. Nevertheless, it is not wise to have too much ground open at any given time, owing to the cost of re-timbering. Along the Mother Lode, most drifts in the ore have to be re-timbered at least every six months. It is the best opinion that reserves enough to supply the mill for two years is a proper compromise between the cost of keeping the necessary workings open and the assurance of an adequate supply of ore.

Another point worthy of emphasis is the accurate sampling of ore in the mine, of pulp in the mill, and of tailing before it runs into the creek. When a superintendent is without accurate information on these matters he is not only pretty sure to be losing much of the metal but is trying laboriously to win, but he cannot check his operations at various stages so as to improve them; in short, he is unscientific. In the old days a grab-sample would be taken and the assay of it would become a tradition. For instance, old Thomas Price, 'Professor' as he was called, a well-known assayer twenty or thirty years ago, took a sample at a mine, still richly productive, and reported that the tailing assayed \$1 per ton, when the ore was yielding \$15 in the stamp-mill. That would be good work, indicating an extraction of 93%. For many years the Professor's dictum was accepted as correct. Finally, accurate sampling was introduced and proved that the tailing averaged \$2.25, after the grade of the ore had fallen. In those days the recognized method of sampling was to place a tin-can at the outflow and allow it to fill, while the water and slime ran away. This, of course, was a rough process of decantation, all the rich slime being carried away and the can filled with the heavy sand, usually the poorer part of the pulp. Another source of error was due to the fact that the millman, much occupied with his multifarious duties, would take a sample in a leisure moment, when the concentrators and other machines were all running sweetly, this being the very time when the loss in the tailing was at its minimum. In these matters we have learned a good deal, as also in cost-keeping and the general recognition that small items of expense become important cumulatively. As to the work underground, the best proof of our gain in economy and skill is afforded by the ability to treat profitably the filling from the old stopes. It used to be the custom to 'resue' or strip the vein, breaking the ore separately from its casing or wall-rock. This Cornish method has much to recommend it in narrow rich veins, but it was over-done. The 'old-timers' failed to get the stringers or 'feeders' in the wall-rock and they were unable to prevent the fine from mixing with the fill, so that in the end 'resuing' was, we venture to say, a wasteful method of mining. Nowadays, we stope the width required for a power-drill, breaking to the full size of the vein and its branches, and then sort out the waste both

underground and at the surface, finding this economical.

These are among the reasons why it is proving worth while to re-open some old mines, particularly in a district where intense mineralization makes it probable that new orebodies are likely to be found by diligent search and intelligent exploration. The Mother Lode is worthy of such ventures; it must be acknowledged. The Kennedy mine is now 3896 feet deep vertically and has been at work uninterruptedly for 31 years. Most of the other important mines have been re-opened more than once. The Plymouth, now so successfully operated by an English company, lay idle from 1888 to 1913. The Gwin, which Messrs. F. F. Thomas [and we pause a moment to record sorrowfully that this honorable engineer and good citizen has just died] and David McClure re-opened in 1894 and closed-down in 1908, is again to be resuscitated, we understand. During the last campaign of 14 years this mine yielded \$3,500,000 gross and \$1,000,000 profit, half of which was put into plant and purchase of adjoining ground. The richest mine on the Lode, the Argonaut, is 4350 feet deep on the dip, equal to 3900 feet vertical; a new hoisting engine has been placed recently on the 3900-ft. level and the shaft is to be sunk 4000 feet more, so say the owners, who have every reason to feel cheerful, the ore at the bottom averaging \$13 per ton. In 1915 Amador county passed Nevada county into first place as a producer of gold. The largest tonnage (17,000) came out of the Kennedy, this mine being only approached in bulk of output by the Plymouth, which produced 129,500 tons. The average yield in the county was \$4.76 tons, of which \$3.11 was won by amalgamation and \$1.65 by concentration, the concentrate averaging \$79.91 per ton. The mines of the Jackson-Sutter Creek district showed an average yield of \$5.51 per ton, indicating ore of considerably higher grade than in the mines northward, which reduced the average to \$4.76, as we have seen. And all this good work is being done unobtrusively—almost too quietly for the fame of the mining district—without the aid of any of those questionable practices that cling to share-dealings on a stock-exchange. The men controlling these mines are veterans, familiar with local conditions and not without acquaintance with districts farther afield; they deserve the success they have won, and we hope it may continue.

The Imponderables

On another page we give our readers an address delivered recently before the Colorado School of Mines by Mr. J. R. Finlay. What he says or writes is interesting, for he is an engineer that can think on his own account and express his ideas in convincing phrase. In this utterance, and in others made by him since the War began, he shows himself much impressed by the material aspect of civilization, by the coal and iron, by the machinery and industrial energies of a nation. The estimation of progress in terms of tonnage and of human ability in units of horse-power appeals, we presume, to

the engineering instinct. From that it is a logical step to the admiration for tonnage and horse-power as produced or applied by large combinations of men and machinery, and to the placing of a bouquet at the feet of the big corporations. A good case can be made for this view of mundane affairs and we acknowledge that Mr. Finlay presents his opinions in an interesting manner. But he does not persuade us in the least. Making every allowance for the stimulation of the arts of life by the great industrial developments of the last half-century or more, we deny the argument that humanity has progressed over slag-dumps or culm-piles. England, Germany, and the United States may exhibit a coincidence of industrial wealth and advance in civilization, but it would be arrogant indeed to deny that peoples lacking the stimulus of material growth have played a notable part in the world's intellectual progress. It is only necessary to refer to one race—the Hebrew—that for centuries was denied industrial participation, that was harried and harassed, and yet out of poverty and degradation produced countless master-spirits of Art. France is an industrial country, she has valuable resources in coal and iron, but who would dare to measure her contribution to the spiritual advancement of humanity by her output of coke or steel? The history of European civilization thunders a denial. The chronicle of our own day, of these calamitous years, proves that the crass materialism fed on coal and iron has stultified Christianity and sent civilization to the shambles. From Cambridge, Massachusetts, not Chicago, Illinois, nor Oxford, nor Manchester, have we drawn our inspirations. The great universities may no longer be found in Egypt or Greece, but the argument of a vanished learning is like that of the man who remarked on the providential fact that the big rivers were near the big towns. Universities are placed near the centres of population. We like the man who prefers to use a steam-shovel rather than a mob of shovellers, for he shows intelligence, but we demur to the suggestion that such a man "is likely to have valuable ideas about Art, Literature, Science, etc." That type of man, unfortunately, is only too likely to read the tape in preference to Shakespeare and to prefer watching the ticker to looking at a Corot. It is a sad fact that devotion to machinery is not usually compatible with love for the things that have no price. Darwin's love for music was atrophied by the grinding of generalizations. The delight in the machine and the absorption in the work of producing the raw materials of civilization are not necessarily favorable to "Art, Literature, Science, and Government;" on the contrary, we see plenty of signs that they deaden the finer perceptions and the greater preoccupations. The doctrine that concentration of commerce and congestion of trade are identical with human welfare and national progress is worth tracking at this time when our country is in the midst of an orgy of industrial success with the great cities across the Atlantic are spending themselves unreservedly in a fight for great principles. We need to be reminded that not the ton of coal or iron, nor even the dollar, is the only

unit that enters into the account between man and his destiny. Thuxley, speaking at the opening of Johns Hopkins University, in 1876, said: "I cannot say that I am in the slightest degree impressed by your bigness, or your material resources, as such. Size is not grandeur, and territory does not make a nation. The great issue, about which hangs a true sublimity, and the terror of overhanging fate, is: What are you going to do with all these things? What is to be the end to which these are to be the means?" That great philosopher would not have been impressed by the number of employees in the service of the corporations that served Mr. Finlay's convenience between New York and Denver. He would regret having to trouble so many! Nor would the multifarious activities of the Guggenheim brothers evoke his admiring astonishment, although he would respect the technical skill exhibited in their mining and metallurgical operations. The great expositor of the evolution theory would question the necessity for agglomerating undertakings in Chile with others in Alaska, and he would ask whether the consolidation of industrial enterprises had not progressed beyond the evolution of a super-man capable of controlling them efficiently. Assuredly he would have ridiculed the statistical theory that the output of coal and iron measured national greatness. No; the great imponderables outweigh them, and not even the heft of the sword shall change the judgment of the eternal scales. As engineers, we rejoice in technical achievement; we take our part in the exploitation of national resources, we recognize how much of material comfort and convenience has come to man from the digging of metal and the fashioning of machines; but we know how to observe, we have read history, we have imagination; let us then not be fooled into thinking that the making of munitions is as fine as the personal service in the trenches, that the lending of money compares with enlistment in a great cause, that the trade in copper is as splendid as the right hand of self-sacrifice.

The Burma Mines

In a recent issue we referred to the Burma Corporation, which owns the Bawdwin mines, in the Northern Shan States. Since then we have received the company's annual report, in which is recorded the latest estimate of ore reserves. It shows 2,300,000 tons containing 25.4 ounces of silver per ton, 27.5% lead, and 22.2% zinc, besides 733,000 tons of "anticipated additions" to which no definite assay-value can be assigned, making 3,033,000 altogether. A deduction of 5% in volume is made for vugs. Metallurgical tests indicate that two products can be made: (1) a lead concentrate comprising 39% of the weight of the ore and assaying 45 oz. silver, 55% lead, and 11% zinc, the recovery being 70% of the silver, 79% of the lead, and 24% of the zinc; (2) a zinc concentrate comprising 35% of the weight of the ore and assaying 15 oz. silver, 10% lead, and 45% zinc, with recoveries of 21, 13, and 68% respectively. The combined metal recoveries would be 91% of the

silver, 92% of the lead, and 92% of the zinc, but in concentrates, of course, not as refined metals. Such concentrates were "easily saleable" says the report, "before the War, and on pre-war contracts would yield good profits." At present selected silver-lead ore is being concentrated on the spot, the product being treated in the company's smelter at Nanttu, 13 miles from the mines, pending further arrangements. The capacity of the refinery has been increased to 1100 tons per month. Meanwhile further tests and arrangements are pending for the disposal of the major produce of the mine, the zinc-lead ore. In the article in which we mentioned the Burma Corporation as a source of zinc, we referred to the purchase of the Swansea Vale smelter, in South Wales, by a syndicate headed by the group controlling the Zinc Corporation. We learn now, through *The Mining Magazine*, that the purchaser is Mr. R. Tilden Smith, one of the principal shareholders in the Burma enterprise. Nor will the Zinc Corporation spend a large sum of money on another smelter, as was announced in London recently. The zinc-smelter business is as hopelessly muddled now as it was nearly two years ago, the British authorities having failed to appreciate the importance of the matter, despite the urgent representations of the producers and consumers of spelter in the Empire.

Since the above was written we have read the account of the recent annual meeting of the Burma Corporation, as reported in the London financial press. On that occasion Mr. Theodore J. Hoover, who is chairman of the Technical Committee, brought his estimate of ore up to date and stated that 3,500,000 tons had been proved above the Tiger Tunnel, which is the main drainage adit. He described "an inner core of most phenomenal richness," this core being 850 feet long by 45 feet wide and containing 600,000 tons of ore assaying 40% lead, 23% zinc, and 37 ounces silver per ton, so that it consists of 63% solid metal. His forecast of profit is \$15 per ton, to be won at the rate of \$5,000,000 per annum. Any money needed for capital expenditure can be obtained from the rich core by extracting 40,000 tons annually for a year or two. The enterprise started by smelting an old accumulation of slag made by the Chinese; now the smelter at Nanttu is treating the old slag and the ore from the mine in equal proportions, and the tendency will be to increase steadily the proportion of mine product and to decrease that from the old smelter-dumps. Investigations are being made preparatory to building a zinc smelter in England, with a subsidiary plant in India, where coal and labor are cheap. The German contracts, under which some of the zinc ore was sold before the War, have been cancelled by order of the British Government, so that the company is free to make new arrangements. In many respects the technical operations of the Burma Corporation are of unusual interest and we hope to keep our readers advised concerning them. Mr. H. C. Hoover, the chairman of the company, has resigned, temporarily, owing to his absorption in the work of the Belgian Relief Commission; but he continues to be a member of the board.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and scientific questions relating to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Prospecting

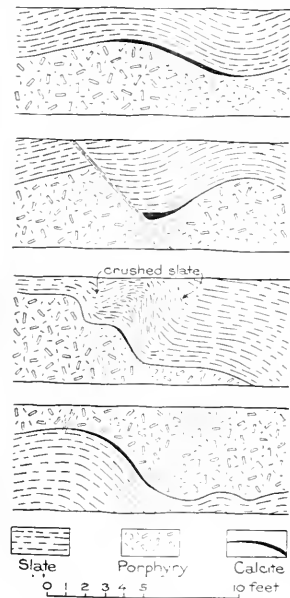
The Editor:

Sir—In your issue for July 22 appears a letter from Harold French headed 'Prospecting: A Suggestion.' Mr. French offers a good example of a plausible theory that would not work in practice.

In the first place it would be impossible to get experienced prospectors to work under the conditions proposed. Such men rightly have a high opinion of their

abilities and would insist on receiving at least a half-interest in all valuable discoveries.

There is no region in the United States where a mine may be found by superficial prospecting. In other words, it is extremely unlikely that there are still any undiscovered visible outcrops of profitable ore on the public domain. The Siskiyou country mentioned by Mr. French as the goal of his hypothetical prospecting expedition is one of the least prospected regions because it is one of the most inaccessible. I spent three seasons prospecting in that region and am more or less familiar with it. Every summer



IRREGULAR POCKETS IN MAD MULE MINE, SISKIYOU COUNTY.

there are many prospectors scattered over the Siskiyou hills singly and in parties of two or more. Most of them are experienced men and their work is quite thorough. They have long since ceased to look for outcropping orebodies and now use the methods of the pocket-hunter. By the way, the finding of orebodies by pocket-methods is a science in itself and one not taught in the schools.

Any experienced prospector will see that the blocking out of 150,000 tons of ore during the month of August or any other month on a raw prospect is an absurdity.

After the discovery of a promising outcrop a large amount of time and often much money must be spent in order to find the proper place to begin blocking out operations. Also, more often than not, the promising outcrop does not fulfill its promises and we are forced to begin the search over again. \$5000 would make a mine of some prospects. It took over \$1,000,000 to bring the Calumet & Hecla to the dividend stage. No two are alike.

In my opinion an 'exploration syndicate' could be made a success, but it would be necessary to operate on a much bigger scale than that proposed by Mr. French. A capital of \$1,000,000 or more would be necessary and it should be understood that the majority of the prospects thought promising enough to justify the expenditure of money for development work will prove to be worthless. However, one real mine will offset a number of failures.

JOHN B. PLATTS.

Oatman, July 24.

[We have added the sketches (after the U. S. G. S.) of the pockets of ore found in the Mad Mule mine, which is in Siskiyou county, as illustrating Mr. Platts' remarks.—EDITOR.]

Flotation on Silver Ore

The Editor:

Sir—Last fall we started up a 100-ton flotation plant on the Monitor-Belmont mines here, at Belmont, in Nye county, Nevada. I believe this was the first oil flotation plant in Nevada for the treatment of silver ores. The ore is crushed through 70-mesh screens and pumped to a Dorr thickener. From there it flows to the flotation-machine. At present we are using 12 cells of the Minerals Separation type with sub-aeration, followed by a pneumatic machine somewhat on the Callow order. Our extraction and ratio of concentration are now quite satisfactory, but we have had one experience that, I believe, you will like to hear, particularly since we learn that others are having the same difficulty, and that is in the taking care of the concentrate after it is made.

We installed a continuous filter to drain our concentrate. The original installation provided for taking the froth over the lip of the feed and mud line without the introduction of air from a blower and then the filter handled the froth nicely, and later when all the froth came from the pneumatic machine the filter had no difficulty, but after we added the sub-aeration feature we

found it an impossibility to utilize the filter. It had an ample capacity too—all we asked of it—but the makers only claimed that it was intended to take a product that was at least 50% solid and preferably 60%, while ours with sub-aeration was about 10% solid. We put in two cones, hoping to thicken it sufficiently before putting it into the filter, but a considerable portion of the concentrate would stick to the sides of the cones and later would come down with a rush, plugging them up. Then it would take considerable time to start them flowing again, and the cones were generally running over the sides and also taking back a very rich product to the Dorr thickener and on through the system again, and we were losing a considerable quantity of concentrates on the floor, so we conceived the following idea, in desperation:

We built six tanks, each 4 by 4 by 16 ft. long, in the lower part of the mill. These were built of the lumber we had on hand, 2-in. planks, which we tongued and grooved and kept full of water for a few days. We built these in two series of three tanks each and we took the froth direct to Tank No. 1 and allowed the water and froth to run over the top into tank No. 2 and from that to tank No. 3. We put the small 1½-in. pump, which had been doing service on the filter, to pumping the overflow from tank No. 3 back into the Dorr thickener. We ran on these tanks until No. 1 was solid and No. 2 nearly so, No. 3 being only partly full. Then we changed the delivery to tank No. 1 of the second series and repeated, and emptied the first series. We made small doors in the bottom of the end through which we shoveled the concentrate and from there to the drying-plate. This concentrate contains 25 to 30% moisture and if we had the elevation we would have taken this product to the filter before putting it on the drying-plate, as it was then in the proper condition. We have discontinued the use of the filter.

The light froth builds up several feet above the height of these tanks, but we add boards to hold it in, and in due time it settles back into the tank. We are now having no difficulty in taking care of our product and the loss in so doing is negligible.

LLOYD G. NELSON.

Belmont, Nevada, June 30.

[This letter is interesting. It exemplifies the use of a good machine under conditions for which it was not designed and for which it was never intended. Obviously, the employment of a filter on a pulp containing only 10% solid is incorrect. We venture to suggest that experience would point to the placing of a thickener before the filter, instead of the settling-box system, which is an old device that has been discarded ever since mechanical thickeners became available. Moreover, the lack of fall below the tanks and the consequent want of elevation for a filter is a reflection on the design of the mill, not on the filter. Indeed, the description fails entirely to reflect on the usefulness of the continuous filter; it simply illustrates how such usefulness can be spoiled by a misconception of the proper function of a specialized machine, which has proved itself invaluable wherever a flotation product needs to be drained. The obvious course to take, when

it was found that sufficient fall was not available to carry the thickened pulp from the settling-tanks, would have been either to lower the level of the filter or elevate the pulp to the filter rather than send a thickened pulp carrying some 30% of moisture to the drying-floor. Mechanical filtration is more economical than dewatering with the aid of fuel.—EDITOR.]

A Traveler's Library

The Editor:

Sir—Could you, through an article in your widely read columns, inaugurate a discussion as to the most suitable library of general technical reference books for an engineer on foreign service? The text-books used during a college course are generally so many and of such size and weight that their transportation in these lands of mule and 'pit-pan' travel becomes an engineering problem in itself. Therefore emphasis should be laid upon compactness and number.

San Salvador, July 16.

SUBSCRIBER.

[We shall be glad to receive suggestions.—EDITOR.]

FOREIGN TRADE has developed so rapidly that attention has been directed to the great ports of the world. Before the War introduced unusual conditions, the six greatest ports in point of annual total value of foreign commerce were New York, Hamburg, London, Liverpool, Rotterdam, and Antwerp, ranging between \$1,000,000,000 and \$2,000,000,000 each in imports and exports per annum. Of secondary importance are Hull, Bremen, Marseilles, Havre, Trieste, Buenos Aires, Calcutta, and Bombay, each having a foreign trade between \$300,000,000 and \$700,000,000. Ranking next in importance are Manchester, Southampton, Glasgow, Dunkirk, Genoa, New Orleans, Galveston, Boston, Montreal, Santos, Rio de Janeiro, Shanghai, Yokohama, Kobe, Singapore, Alexandria, Sydney, Melbourne, Bordeaux, Philadelphia, Baltimore, San Francisco, and Havana. It is worthy of note that the whole foreign trade of Japan, even with the added impetus of War conditions, is scarcely more than a quarter of that of the single city of New York, Liverpool, or London.

Four American banks, all in New York, are now included in the list of the 20 great banks of the world, having each over \$200,000,000 in deposits. First in the list is the Imperial Bank of Russia with deposits of \$760,405,000; second is the Bank of England with almost the same amount. Then follow three other London banks, and sixth is the National City bank of New York, which in 1913 was 17th and the only American bank in the list. The three other American banks now included are Guaranty Trust Co., National Bank of Commerce, and the Bankers Trust Co. The Bank of Montreal is also listed. In the list for 1913 were the Hongkong & Shanghai Banking Corporation, Bank of Spain, and Banco de la Nacion Argentina. No Japanese bank is in the list.

The Problem of Efficiency

By James R. Finlay

*If I were to try to do what I fear you may expect me to do, namely, to discuss the various technical improvements in the art of mining which have come forward in the past few years, I could do little more than recite a long list of them. Moreover, I should probably be trying to talk about something that your graduating students know better than I do. Nevertheless I shall try to be technical. Perhaps I may succeed in drawing your attention to some of the most practical of subjects that your graduates will face at once and will continue to face all their lives.

This school is engaged in the business of preparing young men for the industrial career known as mining. It occurs to me that it may be interesting, even valuable, to pass in review some of the major conditions under which an industrial career is carried on. I wish to call your attention to the proportion of things in the world's affairs: how important power-driven industry is, how it gives rise to industrial corporations, and how large a part these corporations play in our every-day life and particularly in the mining business, and how success in the business of mining depends so largely upon knowing how to deal with them. And through all this I should like to convey the impression that after all there is nothing so valuable as a good mind properly trained.

The essence of modern industry is just this: A man equipped with his muscles and his brain develops about one-twelfth of a horse-power and he can use it for perhaps eight hours per day. You pay him for doing this, say, \$3. The same amount of mechanical energy can be purchased in industrial communities for less than one cent. Therefore, it is perfectly plain that in these days when you hire a man you are paying not particularly for his muscular energy, because if you were buying energy you could buy four hundred times as much in another form for the price you pay your laborer. You pay your laborer for using his brain to direct not only his own muscular energy but the mechanical energy, so vastly cheap, that can be supplied to him through machines.

In mining I see nothing to separate it widely from other forms of industry. The mere fact that the miner digs material out of the crust of the earth does not make his methods essentially different from those of the man who makes use of materials already lying on the surface. The problem of mining industry today is the problem of applying the greatest amount of mechanical energy that can be used effectively by a unit of human energy.

Having stated the thing this way, we come at once to the important fact that this problem is the problem of corporate effort and not of individual effort. The energy

from a power-plant cannot possibly be utilized by a single person; nor can it be built, or the machines in it manufactured, by individuals. Power-driven industry even in its crudest form implies collective effort. To take an example from the history of mining, when the gold-hunters first came to Colorado, or more certainly when they first went to California, they used no machinery. They used tools, picks, shovels, pans, rockers, and wheelbarrows, but not steam engines. So long as they worked that way each man could work effectively by himself; and in the placer days of California nothing was heard of corporations. The gold was produced by a nameless swarm of independent workers. But when they began to operate lode mines, in which steam-engines must be employed for pumping, hoisting, and stamping, that was an enterprise calling for a number of employees; it took collective effort, it produced the corporation immediately. The same kind of illustration can be found in any other industry that uses mechanical power. Thus in transportation, so long as it was a question merely of pack-animals or wagons, the individual unit was nearly, if not quite, as effective as a corporate unit. One man with his team could haul as cheaply as a company managing ten men with ten teams. Not so when they came to use steam, or any other form of power for transportation. Your locomotive needs a roadbed and rails; it must have cars. The thing needed collective effort and capital.

It is well to remember that if this country had remained in the industrial status of the time when the Declaration of Independence was made we might by now have had our population of a hundred million people, but practically the only corporations we would have known about would have been the Central Government, the 48 States, innumerable counties and cities, and also religious corporations, churches, and colleges. But under those conditions it would have taken a month's hard travel to go from Denver to New York, you would have been lucky here in Colorado to get an answer to a letter sent to New York in two months, while as it is you can get one easily in a week; indeed, if you are in a big hurry you can talk to New York by telephone in 15 minutes.

One essential thing in bringing about this change, besides the invention of appliances, has been the development of a new kind of corporation, the business or industrial company, to supplement the governmental, and educational corporations that had been known before. It cannot be said truthfully that these business corporations are entirely the result of the use of mechanical power, for trading, financing, and other commercial companies have been known for many hundred

*Address before the Colorado School of Mines at Golden

years; but it is quite true to say that their great importance as a factor in daily life comes from the use of mechanical power.

In this way it seems to me that the development of mechanical industry is greatly widening the exercise of human intelligence. There is exercise for great ability in directing the innumerable business corporations, manufacturing concerns, transportation concerns, mining concerns, in every one of which there is a distinct reward for the man who can make a little better mixture of the ingredients of efficiency; but it is not only the managers, but practically all of the employees who have a widened scope for the exercise of their brains. Anyone who exercises power beyond those of his own body is using his intelligence more than he otherwise would. Thus, the man who drives a locomotive must have experience and knowledge above that of the man who simply walks. These are facts that no intelligent man can deny. I believe it to be an absolute fact that those regions and those races which have developed industry best have developed mentality best. They have developed industry because they have had the mentality; and while this is true, I think it is also true that a prosperous industry attracts good human material to it. A man does not think highly who is content with stupid unproductive labor. Of course, people without high intelligence may move a lot of coal and iron; but which is the more intelligent man, he who insists on moving coal and iron with his bare hands or he who does it with a steam-shovel? I think the question needs no answer. Moreover, I fully believe that the man who wishes to use a steam-shovel and make it work is the more likely to have valuable ideas about Art, Literature, Science, and the Government, or whatever manifestation of mentality is desired.

The mechanical industries that have sprung up in the United States and Europe have produced great prosperity and this prosperity has helped to develop not only the natives of these regions, but it has induced ambitions and intelligent people to migrate to those areas from other parts of the world.

The proof of the pudding is in the eating! Where are the seats of learning today? Where do you go to learn Art, Literature, Science, Music—anything you can think of? You do not any longer go to Italy or to Greece or to Egypt to learn these things. You go to the great industrial countries, the United States, England, Germany, and to those portions of France that are more particularly industrial. It should be pointed out that power-driven machinery is made of metals, particularly of iron, and driven by coal. It is natural, therefore, that industry should be most active in those regions where iron can be successfully manufactured. This is the case to a greater extent than most people realize. The areas of the world in which iron is successfully manufactured are relatively small. There are two great areas: A belt bordering the Great Lakes from the upper Mississippi to the Atlantic coast in the neighborhood of New York, and another belt extending from the Irish Sea across

England and into Germany, including Belgium and northern France. These are the areas in which at least 90% of the iron of the world is manufactured and a very large percentage of the machinery operated. And what do you find there? You find the six greatest cities of the world, one after the other.

The more you examine into it the more you will be impressed by the fact that these areas have become the market and the clearing-house of the world's commerce, the centres to which all other metals, including gold, must go to be utilized. You will notice further that these areas hold the reins of power in human affairs. You find there the financial, political, military, intellectual, social, and artistic capitals of the modern world, to which not only every article of trade, but human intelligence itself, goes for cultivation and development.

It seems to me worth while to lay stress on this situation because a great many people would like to believe what I have said is not all true. There are those who would have us believe that we are focussing our attention too much on the pursuit of industry and wealth; that by so doing we miss the chance to develop higher and better things. You will be told, for instance, that the growth of corporations is turning us into a nation of employees, another name for slaves; that after all only a few can be leaders, the rest must be followers; that the opportunities for personal initiative and independent action are being swallowed up in a flood of corporation routine which will end by giving human life the monotony of machine-made goods. There may be some truth in this, but whether it is true or not, I believe that we are in an age where the tendency is irresistibly in the direction of the continued growth of corporations. Whether we like it or not, we shall have to accept it. It is an element of common sense to accept the inevitable, not only with resignation but with cordiality.

But I do not look upon this development as undesirable. We are living in a great age, which will be called by future historians the age of the conquest of natural forces by the human mind. There was a similar age thousands of years ago in prehistoric times when men domesticated animals and plants; when they exchanged the free life of mere hunters for the exacting and settled life of agriculture and trade. By giving up a portion of their freedom those ancient people found that they were repaid by a great expansion of the possibilities of life. We are doing the same thing in a different way. The old hunter was persuaded to give up his freedom to wander in order to enjoy freedom from hunger. Our people are being persuaded to give up a portion of their freedom of individual effort and undergo the discipline of the collective effort, for the privilege of having a lot of things and of doing a lot of things which they could not have or do otherwise.

To illustrate how far the activities of corporations affect our daily life, I thought it would be interesting to find out how many people were employed by the corporations with which I would have to deal in coming from New York to Denver. I went through this simple

process: I received a telegram from Mr. Phillips, traveled over the Pennsylvania and Burlington railroads in Pullman cars, and upon arriving at Denver talked to Mr. Phillips over the telephone. I find that in order to do this I had to depend on corporations as follows:

The Western Union Telegraph Co. employs	40,000
Pennsylvania Railroad	225,000
Burlington, Northern Pacific, and Great Northern	100,000
Pullman Palace Car Co.	30,000
American Telephone & Telegraph Co.	150,000

A total of, say..... 551,000

If we add to these the United States Steel Corporation, which makes a good part of the rails, bridges, and cement for these structures, the Baldwin Locomotive Works and American Locomotive works, which build the engines, we should find that the corporate machinery we depend upon to make this trip would soon count up to a million employees—in eight concerns alone. The Steel Corporation alone is employing about 250,000.

In getting this information I secured the last annual reports of a number of these companies and I found in them a number of bits of information well worth knowing. For instance, I find that the Pennsylvania railroad has either as pensioners or employees 4300 men who have been in the service 40 years and upward. This is a good example of how these corporations affect people's lives. Another thing is interesting to mining people. The Pennsylvania handled last year 142,000,000 tons of freight, of which over 60%, nearly 86,000,000 tons, was the product of mines. To this we could add 8,500,000 tons of manufactured iron and steel, so that the total freight really coming from the mines amounts to nearly two-thirds of the total.

I find, moreover, that this concern is owned by 93,936 stockholders of whom 45,906, or nearly half, are women. Its funded debt amounts to \$728,353,615, held by about 100,000 bondholders. Its employees number about 225,000, so that altogether the number of people who depend partly or wholly upon this concern for their livelihood exceeds 400,000.

I think few of us realize on what a colossal scale these concerns are co-operative industries. They are owned literally by the public. There is no stockholder of the Pennsylvania who owns 2% of the stock. The board of directors and the officers, numbering in all about 90 men, are said to own altogether less than 5% of the stock.

Almost every one of these reports contains something of interest. In that of the American Telephone & Telegraph Co., I find this sentence: "The radius of dependable commercial speaking transmission has been very greatly increased, and it is now certain beyond any question that as fast as developed or potential business and social requirements indicate commercial practicability, every section of the country can be put in speaking transmission with every other section, and every subscriber to the Bell system will be able to speak to every other subscriber, regardless of distance." The report goes on to explain partly how this has been accomplished,

but I have no time to enter into that. The thing I am trying to bring out is the kind of efficiency these corporations are securing, and how the telephone as a mechanical device has been supplemented by far more intricate corporate device, human mechanism of 150,000 parts, in order to put the enormous convenience of this telephone at the service of the public. These concerns are not mining concerns, but we find the same thing going on in the mining business on fully as great a scale. The United States Steel Corporation is the greatest of industrial corporations and it is a mining and metallurgical concern.

It will be of more interest, perhaps, to take some note of the growth of mining corporations in the West. This hall bears the name of Guggenheim and this suggests discussion of a great mining and metallurgical concern that originated right in Colorado. Moreover, a brief inquiry into the rapid growth of the Guggenheim interests will serve as well as anything else to illustrate the forces that are causing that growth.

The group of enterprises operated by the Guggenheims makes as yet only a modest comparison in point of size with the great corporations I have mentioned. They employ only 35,000 to 40,000 men. The companies under their management are the American Smelting & Refining Co., the Federal Mining & Smelting Co., the Kennecott Copper Co., the Nevada Consolidated Copper Co., and the Chile Copper Co. I suppose there are other ramifying interests. Of these the largest industrial unit is the American Smelting & Refining Co., which in 1915 employed 15,500 men in the United States, and I understand about 10,000 in Mexico. I shall not take up your time by tracing the history of this company except to remind you that its present size is largely the result of consolidations made during two or three years from 1899 to 1901. Before that time the properties of which it now consists were divided among at least 20 separate companies. An immense amount of mining property and smelting property has been acquired by purchase or has been constructed by the consolidated company. As in the case of the Pennsylvania railroad, I wish to call your attention to the fact that the American Smelting & Refining Co. is owned, I believe, by about 15,000 stockholders. There is no dominating owner, or group of owners. The Guggenheim brothers only own a few percentages of the stock. They and their friends, however, continue to dominate the management, because that management is good and there is nobody among the stockholders to challenge it, not any feeling of discontent among the stockholders to make them wish to change the management.

This concern is beloved by many people who are competent to judge to be in the very front rank of efficient corporations. Its growth is built upon that efficiency. There is nothing in the least mysterious about it. The men at the head have breadth of view and the faculty of leadership that enables them to keep the company well equipped in three essentials, adequate finance, organization, and technical skill.

Magnesite Production and Markets

By Samuel H. Delbear

Magnesite from foreign countries was less available in 1915 than in the previous year. From the Austria-Hungarian deposits some shipments were received until March of last year. The Greek mines continued to export occasional cargoes to the United States, and doubtless would send more were it not for the scarcity of ships. The following gives imports that reached American ports from foreign countries, in short tons, being for the year 1915:

Austria-Hungary	52,086	Netherlands	3,554
Germany	722	England	129
Greece	4,437	Scotland	150
Denmark	103	Canada	948
Italy	710	Venezuela	508

These figures do not mean that all of the countries named are producers of magnesite. High prices in the United States caused re-shipment from some of these countries. Total imports into the United States during 1915 are reported as 63,348 tons of calcined and 18,731 tons of crude material. Prices rose during the latter part of the year. Imports of calcined magnesite decreased heavily, whereas nearly five times as much crude was imported as in 1914.

CALIFORNIA. The domestic production of magnesite in the United States during 1915 was 30,325 tons of crude, which includes 10,951 tons of calcined; as against 11,293 tons, estimated as crude during 1914. Production during 1916 will no doubt greatly exceed that of any former year. Because of the difficulty in securing imports, the demand for the Californian product has been active and many new mines are now shipping ore. Tulare county continues to be the most important source. The chief development in that region has been the re-opening of the deposits abandoned by the Tulare Mining Co., and purchased by the Porterville Magnesite Co., and the operation of a new mine of great promise adjoining that of the Tulare Mining Co. on the south fork of the Tule river, 14 miles north-east of Porterville. A 5-mile rail-extension has been made, and a tramway built, giving excellent transportation. The development of this mine was commenced by S. R. Coghlan and T. E. Frederick in the latter part of 1915, the mine being sold subsequently to R. D. Adams of the Lindsay Mining Co. Doyle & Smith have opened another new deposit in Frazier valley; so have Cook & Langley in the vicinity of Deer creek, where an excellent grade of ore is being mined. The California Magnesite Co. operated several leases in the Porterville district, and commenced the erection of a large calcining plant. Their work was later interrupted by litigation. Aside from the mines mentioned there are many smaller ones yielding one or more carloads per month. Shipments from

the Porterville district in May, 1916, totaled 127 carloads.

The Tulare Mining Co. continues to remain the largest producer in the State. All of the product from its Porterville mines is calcined. The company operates two shaft-kilns. It also made shipments of crude ore from its Napa county deposits.

In Sonoma county, the Sonoma Magnesite Co. com-



MAGNESITE VEIN OF LINDSAY MINING CO.

pleted a rotary calciner, and shipped some calcined material. This was hauled 14 miles to Guerneville, the projected narrow-gauge road having been completed recently.

The Refractory Magnesite Co. re-opened the old Creon deposits near Preston in Sonoma county, and shipped several hundred tons of crude ore, which was calcined at the plant of the Pacific Carbonic Gas Co., the carbon di-oxide content being recovered. This mine yields an unusual ore, having a greenish cast due to the presence of iron carbonate. On calcining, the ore becomes dark-

brown, the iron carbonate present being reduced to an oxide that is somewhat magnetic. A shaft-kiln is now calcining ore at the mine.

At Bissell the Rex Plaster Co. extracted several thousand tons from sedimentary deposits, a part of which was calcined in the company's rotary kiln at Los Angeles.

In Santa Clara county the Western Magnesite Development Co. has shipped both crude and calcined ore. The reduction plant is situated near the mine, which is on Red mountain, and motor-trucks are now employed in hauling the product to Livermore, a distance of 35 miles.

At Madrone, in Santa Clara county, H. Sherlock has shipped several hundred tons of impure magnesite. This was calcined at the plant of the Pure Carbonic Gas Co.

cesium salts with alkaline carbonates. The following are representative analyses:

SiO ₂	11.12	11.82
Al ₂ O ₃	0.98	0.94
CaO	5.36	5.20
MgO	36.72	36.40
Loss in ignition	14.15	43.45
	98.33	98.51

Considering that buyers of magnesite have established a maximum admissible limit of 5% SiO₂ and 3% CaO, this product would appear to be too low-grade.

CANADA. Magnesite was mined to some extent in Canada during the past year, in the township of Grenville, in the province of Quebec, and in Atlin township, Yukon Territory, and in the Lilloet district, 93 miles

north of Ashcroft. Canadian magnesite is usually high in lime, much of it containing 10 to 15% CaO. About 1000 tons was shipped into the United States during 1915, and it is believed that there is little likelihood of many future shipments owing to the impurity of the product.

MEXICO. The International Magnesite Co. commenced shipment of crude magnesite from its deposits on Santa Margarita island in the Gulf of California. The ore is brought by water to Chule Vista, California, near San Diego, where it is calcined in a rotary-kiln. The capacity of the plant is stated to be



ROTARY CALCINER FOR CALIFORNIA MAGNESITE CO. AT PORTERVILLE.

at West Berkeley, the carbonic gas recovered, and the residue sent to a paper-mill in Oregon for making pulp.

The White Rock mine, in Napa county, yielded several hundred tons of crude ore, which was shipped from Rutherford. Aside from the more important deposits mentioned, there are many smaller operations being conducted in various parts of the State.

Production of California by counties in short tons is as follows. (equivalent to crude) tons:

Sonoma	3,729
Santa Clara	7,270
Tulare	12,116
Napa	1,050
Other counties	6,890
Total	31,055

NEVADA. The discovery of a large deposit of magnesite in Clark county, a few miles from the town of St. Thomas, has been reported. This is said to be similar to that at Bissell, in California, which is of sedimentary origin. Magnesite is considered to have been precipitated by the contact of solutions containing soluble mag-

nesite with alkaline carbonates.

22 tons of calcined magnesite per day.

MARKET. The price of crude magnesite ranged from \$5.50 to \$12 per ton during 1915. Calcined magnesite sold at a wide margin, namely, \$20 to \$60, hence no fixed price can be said to represent the market. Domestic calcined magnesite in bulk sold for \$25 to \$30 per ton f.o.b. San Francisco, or other California points. When ground and packed in barrels, the price ranged from \$40 to \$60 per ton. Powdered Greek magnesite, when available, brought similar prices at San Francisco. Early in 1915 Austrian calcined magnesite was quoted at \$22 to \$25 per short ton, and Greek caustic magnesite, not ground, \$29 at ships' tackle in Atlantic ports.

MAGNESITE is used in the rubber industry. After calcining, the ore is ground to pass 200-mesh, after which it is put through water. The contained silica precipitates, the lime is dissolved and is taken up by water. The pure magnesite floats. The dried product is packed in paper-lined barrels and sells for 10 to 11c. per lb. to the rubber people.

The Re-Opening of Old Mines Along the Mother Lode, California—II

By T. A. Rickard

The Mother Lode is a gold-bearing fissure that traverses the western foot-hills of the Sierra Nevada in a line parallel with the main axis of that mountain range, which separates California from the State of Nevada. The productive portion of the Lode extends from Ophir in Mariposa county to Placerville in El Dorado county, a distance of 71 miles, but the full length of the Lode is about 125 miles, for it is stated to have been traced from Fresno county to mine workings north of the American river, into Placer county. The richest portion is within Amador county, where a nearly continuous series of productive mines extends along the strike of the Lode for 12 miles, the chief properties in order northward being the Argonaut, Kennedy, Oneida, South Eureka, Central Eureka, Eureka, Wildman-Mahoney, Lincoln, South Spring Hill, Keystone, Original Amador, Bunker Hill, Fremont, and Plymouth Con-

mines has been developed on an eastern spur from the main vein. Likewise across the Stanislaus river into Tuolumne county. But, as stated, the most intense ore deposition and the most successful mining are alike in Amador county, where are the deepest mines. Of these, the Kennedy has reached a depth of 3896 ft. vertically, while the Argonaut, at present the richest mine on the Lode, is down 4500 ft. on the incline, equivalent to 3900 ft. vertically. The recorded production of the Mother Lode region from 1880 to 1914 is \$153,000,000, of which \$69,000,000 is credited to Amador county. Allowing for the production before 1880 and since 1914, it is estimated that the Mother Lode has yielded a grand total of \$230,000,000 in gold, of which \$110,000,000 came from the mines in Amador county.

Statistics for last year, as compiled by Charles G. Yale, of the U. S. Geological Survey, are as follows:

County	Quantity, Tons	Bullion Produced		Gold and Silver Recovered on Plates, per Ton	Quantity, Tons	Concentrate Produced		Value in Gold and Silver per Ton,	Total Recovery, \$	Total Recovery per Ton, \$
		Gold, \$	Silver, Oz.			Gold, \$	Silver, Oz.			
Eldorado	21,428	63,796	418	2.99	403	35,425	540	88.58	99,707	2.65
Amador	819,550	2,519,284	27,144	3.09	17,155	1,364,575	12,521	79.91	3,993,969	4.76
Calaveras	383,808	502,125	4,742	1.31	10,316	388,843	4,824	37.93	895,818	2.33
Tuolumne	248,907	642,948	25,211	2.58	11,226	409,037	1,045	36.48	1,065,297	4.28
Mariposa	48,154	331,282	2,590	6.91	847	52,109	247	61.67	384,981	7.99
	1,521,817	4,059,335	60,405	2.52	39,947	2,249,989	19,177	56.57	6,349,772	4.17

solidated. (See accompanying map).

In this part of the lode-channel the gold-bearing quartz is distributed along one or more well defined fractures traversing black 'slate' (the Mariposa schist) where it is in contact with, or close to, 'greenstone' (diabase) dikes. These ore-bearing fractures have the same strike (north-west) as the country-rock, but they dip less steeply, although usually in the same direction (north-east). The point to be emphasized is the general coincidence of strike and the discordance of dip. In the principal mines the dip averages 65°. Lenticular masses of quartz more than 50 ft. thick are not uncommon, and they are as much as 1500 ft. long, but as a rule they are more persistent in dip than in strike, so that in their shape they resemble chimneys. Thus the Lode is not a single continuous vein but a system of fractures along which gold has been deposited, usually in association with quartz. Where this zone is constricted, the fissuring is almost continuous and the deposition of ore uncommonly persistent. Thus, in Calaveras county, where the Lode is wide and ill defined, the gold veins are scattered and unimportant, except at the southern end of the county, where, at Angels Camp, a group of productive

The counties are arranged in geographic sequence. Silver is estimated at 55.3 cents per ounce. The total of \$6,349,772 for 1915 compares with \$5,075,552 in 1914 and \$4,728,450 in 1913.

In Amador and Tuolumne counties at this time there is increased activity; the productive mines are doing well, and many idle mines are being resuscitated. This has prompted me to make a comparison between economic conditions prevailing, for instance, when the old Eureka mine was in its heyday of prosperity and today, when it is being re-opened. It is assumed by those engaged in unwatering the Eureka workings that the greater cheapness of material and the increased skill of the operators nowadays will enable them to exploit ore that could not be touched 30 years ago and to find ore that was missed by the miners of an earlier period. It will be interesting to enquire into the reasonableness of these expectations.

In 'American Mines and Mining,' a résumé of statistical and other data collected by Rossiter W. Raymond when Commissioner of Mining Statistics in 1871, I find a statement giving the principal items of cost at Sutter Creek on January 1, 1869. It is here appended, with the



TREES GROWING AROUND THE OLD EUREKA SHAFT JUST BEFORE IT WAS RE-OPENED.

corresponding prices prevailing on January 1, 1916.

COMPARISON OF COSTS

	1869	1916
Miners' wages	\$3 per shift	\$3
Surface labor	\$2.25 per shift	\$2.50
Lumber	\$28 per thousand	\$20
Fuel	\$5.50 per cord	\$5
Explosive	\$1.25 per lb.	12c.
Quicksilver .....	.65c. per lb.	70c.
Steel	18c. per lb.	6c.
Freight from San Francisco.....	\$20 per ton	\$4.25
Cost of mining	\$4.67 per ton	\$2.50
Cost of milling	\$2.15 per ton	32c.
Average yield of ore	\$20.34 per ton	\$5
Average recovery	74%	90%

The cost of labor constitutes 60% of the entire expenditure, therefore it is an important fact that wages remain practically the same. On April 1, 1916, however, the chief mining companies operating in Amador county, on the initiative of the Plymouth Consolidated, raised miners' wages to \$3.25 per shift. Surface labor is paid \$2.50 to \$2.75. In making a comparison with 1869, it must be noted that the shift then was 10 hours underground and 12 hours for surface labor; now the time is reduced to 8 and 9 hours, respectively. Whether an allowance should be made for the shorter time of work, I cannot say. My own opinion

is that 8 hours is enough for the man who works conscientiously, and that such a worker will accomplish very little more in 10 hours, but superintendents complain that they do not get 8 hours of real work and that the wasting of time reduces the shift to such an extent as to make the labor more expensive than formerly, when the shift was longer and the worker more willing. This is due partly to the spread of trade-unionism and partly to the change in the composition of the population of Amador county. In 1869 the men were mostly native-born Americans from the older communities east of the Missouri; today

they consist largely of Austrians, Serbians, Italians, and Spaniards.

As regards lumber and wood, there is no noteworthy change. Lumber is a little cheaper, owing to better railway transport, and wood-fuel has been replaced to a large degree by electricity. The materials used in mining—steel and explosive—are much cheaper. Just now dynamite costs 19c. per pound, owing to the War, but 12c. was the normal price two years ago. The consumption varies greatly as between neighboring mines, for instance, from two-tenths of a pound to one pound per ton of ore, so that this item is important.* The cost of steel as given covers the average for all kinds of steel material, such as drills, stamp-shoes, turn-sheets, cars,

*How the consumption of dynamite may vary is indicated by the fact that at the Bunker Hill & Sullivan mine, in Idaho, it is half a pound and at the Alaska Treadwell two pounds per ton of ore.



THE BUNKER HILL & SULLIVAN MINE, IDAHO.
SETTLING UP IN 1869

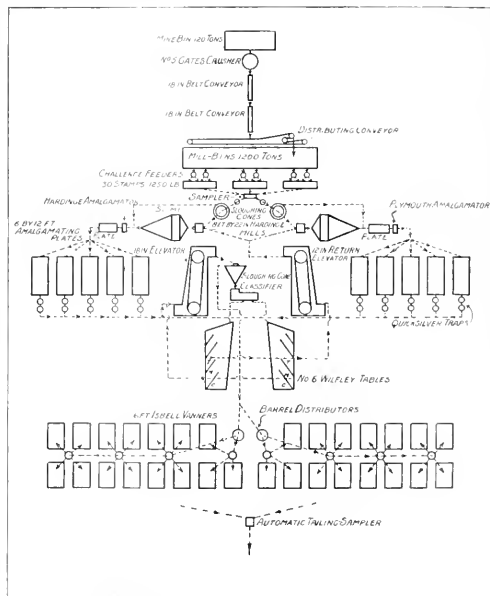
and rails, the last of these costing only $3\frac{1}{2}c.$ per pound, but the others raising the average to $6c.$ All shovels, hammers, and tools generally, are cheaper and better now than they were in 1869. The improvement in this department is emphatic. Quicksilver has been worth \$4 per pound recently, but $70c.$ is nearer the usual price and at that figure it is about the same as 50 years ago; but much less of it is used, and a smaller proportion is wasted, in modern milling.

Freight is important when assembling the parts of a new and large plant, but ordinarily it is not a heavy item in the economy of a gold mine, which requires a relatively small quantity of supplies. An American mining community consumes 12 lb. of supplies per ton of ore produced and a modern gold mine requires only 5 to 6 lb. per ton. Since 1869 the railway has been built from Sacramento to Ione and from Ione to Martel, which is only two miles from Sutter Creek, so that Latrobe is no longer the rail-head for this community, although it still serves Plymouth, which pays \$9 for freight from San Francisco. But, even if the freighting on machinery and supplies be a small item, it is certain that the facilities for the prompt delivery of necessary materials plays an important part in the comfortable operation of a mine.

The cost of mining given for 1869 is that at the Eureka; that of 1916 is obtained from the Plymouth Consolidated, which I quote as typifying the new order of things. The \$2.50 per ton includes 62 cents for development, $40c.$ for construction, and $21c.$ for depreciation; in short, it represents the real cost of mining and is not the illusory figure given so often, namely, the mere operating cost. The cost of milling at Plymouth can be divided into $34c.$ for the milling itself and $31c.$ for the additional cost of treatment and freight on concentrate, which goes to the Selby smelter on San Francisco bay. The total cost of mining and milling is \$3.30 per ton at Plymouth, and this is the figure that the management of the resuscitated Eureka can safely accept as a guide. As to the richness of ore, the old Eureka averaged \$27.38 in 1869 and out of this 74% was recovered; today the Plymouth ore averages \$5.50 and the extraction is 91%; the tailings therefore would contain \$7.11 and 49.5c, respectively in gold. Here we find convincing testimony of the increase of skill acquired by the modern metallurgist. At the Plymouth 30 stamps and 2 conical (Hardinge) tube-mills crush 360 tons per day, or 12 tons per stamp, while the old Eureka mill crushed 2 tons per stamp, in each case the fineness of grinding sufficing for the after-treatment.

The metallurgical treatment is quite different now from what it was in former days. In the old mills the stamps had wooden stems and were shod with iron, dropping in wooden mortar-boxes. Iron and steel slowly supplanted wood in every part. The gold used to be saved by amalgamation first in the mortar itself, on a plate inside, below the screen-outlet, and then on the 'aprons,' which were sloping tables covered with sheets of copper having a carefully prepared amalgamated surface. Screens of 20-mesh were used in the battery.

After the 'free gold,' meaning the gold less intimately mixed with the pyrite, had been extracted by amalgamation, the pulp passed down sluices, as in placer mining, in which the coarser particles of pyrite and other gold-bearing sulphides were concentrated. Blankets were also employed, after a fashion borrowed from Georgia, which derived it from Hungary. In 1871 the concentrate from the Eureka mill went to the chlorination works of Jones & Belding. In the report for 1876 mention is made of Hendy's apparatus, a sort of buddle, which represented one of the earliest attempts to introduce machinery for concentration. The belt machines came much later. For a long time chlorination held the field; even today the Kennedy concentrate is chlorinated; but the other mines now send this pyritic by-product to the Selby smelter, on San Francisco bay, at a cost for wagon-haul, railroad-freight, and treatment of \$12 per ton. The old chlorination mills used to charge \$20 per ton for treatment and pay 90% of the gold in the concentrate. To this, of course, the cost of wagon-haulage had to be added. Ob-



FLOW-SHEET OF THE PLYMOUTH MILL.

viously, the present custom of sending the concentrate to a smelter 152 miles distant is a confession of metallurgical failure. With a revival of technical enterprise, I expect to see the development of a method for treating concentrate locally.

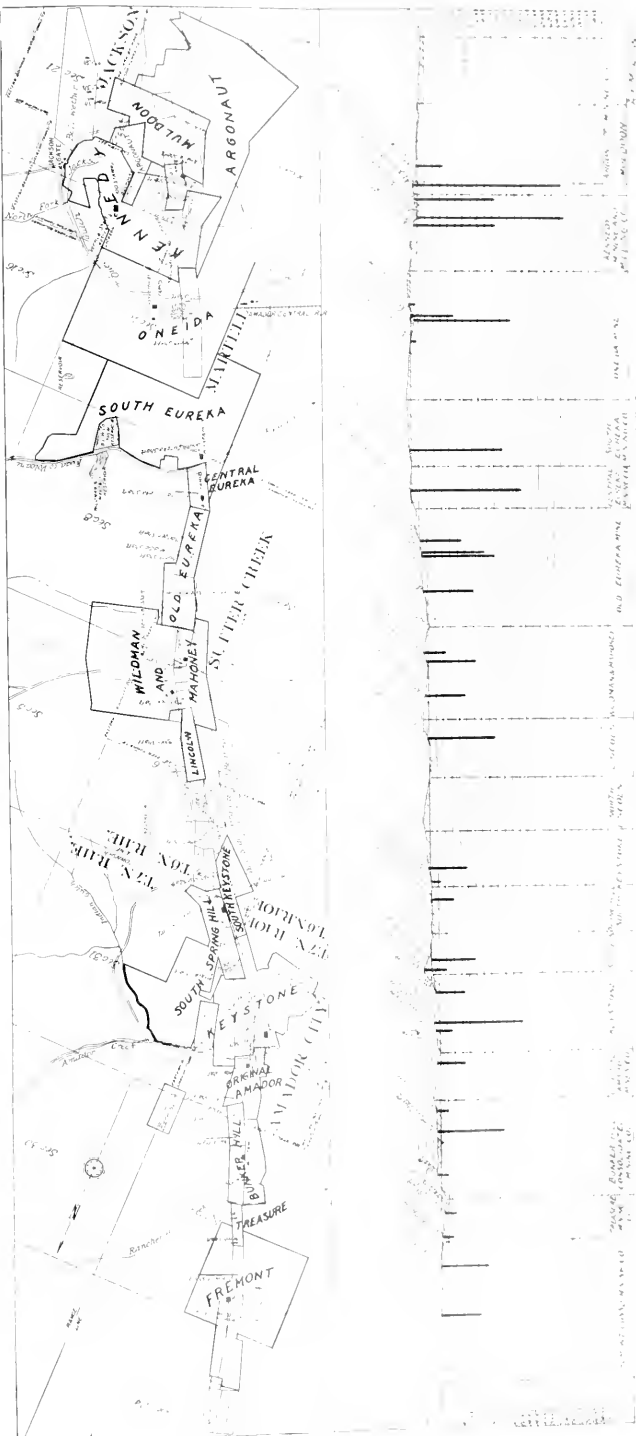
To furnish a contrast with the old metallurgy, I append the flow-sheet of the Plymouth mill, which is the latest, not the last, word in Mother Lode practice. This mill does credit to all concerned. It is clean, dry, and well lighted as compared with the sloppy dark sheds in which the old stamps used to splash. The 'aprons' are covered with silvered copper (1 oz. silver per square foot

SIX MILES OF THE MOTHER LODE IN AMADOR COUNTY, CALIFORNIA

PRODUCTION APPROXIMATING \$65,000,000

COMPILED FROM U.S. GEOLOGICAL SURVEY
FOR THE USE OF THE MINING AND SCIENTIFIC PRESS

0 10 20 30 40 50 60 70 80 90 100
FOOT
0 10 20 30 40 50 60 70 80 90 100
METER



of copper; and are uniformly coated with amalgam, in this respect also affording a favorable contrast with ancient days. The ore as it comes from the mine is fed to a Gates gyratory crusher and distributed by conveyors to the mill-bins, from which it is delivered automatically to the 30 stamps. Then the pulp is re-ground by two Hardinge pebble-mills. From these it goes to the amalgamators, which discharge to amalgamating tables. As first designed the pulp went thence to sloughing-off cones, the overflow from which was uniformly distributed to 24 vanners, while the spigot product from the cone went to a two-compartment Richards hindered-settling classifier, the spigot-product from which in turn was treated on two Wilfley tables while the overflow from the Richards classifier went to six vanners. This part of the flow-sheet has been changed because the feed to the six vanners varied so much as to prevent them from operating satisfactorily; the reason for the variation being the changes in the hardness and coarseness of the ore, and the occasional idleness of a 5-stamp battery. The spigot-discharge from the cone now feeds two Wilfley tables, all the tailing from which goes back to the Hardinge mills to be re-ground. A narrow streak of middling returns to the cone, this middling being a mixture of fine concentrate and fine sand, the result of incomplete classification.

However, the feature that distinguishes a modern plant, like this, from the old mills, is the sampling whereby the superintendent really knows what he is doing. An automatic sampler just below the battery gives the average content of the pulp before metallurgical extraction begins, and another automatic sampler outside the mill checks the loss in the tailing. While the old Eureka mill, for example, is credited with 74% recovery, it may be assumed confidently that this ratio flattered the skill of the superintendent, and that 65% is probably nearer the truth.

It remains to note the use of labor-saving devices. Since 1869 the machine-drill has gone far to replace human muscle. Machines have been introduced in many departments. The use of compressed air for sharpening drills and the heating of the bits with oil-fuel, instead of charcoal, may be mentioned; also the timber-framing machine.

Time is money; the mine-manager of today can expedite his work in many ways, and so accomplish a great deal more underground in proportion to the overhead expense. Rapidity of exploration has been gained by the introduction of the machine-drill. Where Hayward's men used to advance 2 to 3 ft. per day in a cross-cut, their successors now make 7 ft. with a machine. In a drift the speed is just double what it used to be. As the orebodies overlap, or follow *en echelon*, it is necessary to cross-cut freely. That the old-time miners, particularly the Cornishmen, would be slow to do. They preferred to follow a good gouge if no ore offered. As one honored veteran remarked to me: "When the Cornish miners got onto a streak of ore, they would stick to it till hell froze over, and never by any chance drive a cross-cut to find out if they had missed anything." Well, it is the second

rule of mining to follow the ore, the first rule being to find it, so I shall not blame them so severely, but when they "got off the pay" they should have shown no hesitation to cross-cut.

The bucket and hemp rope have been replaced by the skip and steel rope. A bucket used to hold from 500 to 2000 pounds; the skip carries from 2 to 5 tons. The handling of ore underground has been expedited. Huge timbers are not now necessary; for there is more back-filling of stoped ground. Ventilation and pumping have been improved; men work under better conditions underground, with better tools and explosives. On surface, electric lighting, the telephone, and the typewriter facilitate business.

All this tends to reduce the number of men 'on top.' In 1869 the Eureka employed 60 miners, 12 blacksmiths and engineers, 25 feeders, amalgamators, and teamsters, or 97 men altogether, of whom 37 were at surface, to produce 60 tons of ore, that is, $\frac{2}{3}$ ton per man. Nowadays the Plymouth reverses the ratio and produces 97 tons for 60 men, the actual average being 1.8 tons per man. This comparison goes to the root of the economics, for 60% of the cost of mining is recorded on the monthly pay-roll.

Thus the question of the cost of winning gold in this mining region is answered confidently in favor of modern practice. The cost per ton is about one-half what it was 50 years ago and the extraction of the gold is 15 to 20% cleaner. But in mining, especially gold mining, the chief problem is to find the ore. How have we progressed in that regard? I dare to put the advance at 50%. Those early operators—men like Hayward—were shrewd traders but they were not mining engineers. They lacked the scientific training of those who are now re-opening the old mines on the Lode. While geology is still a timid guide to the miner, the engineers in charge of development underground know more about the pitch of ore-shoots, post-mineral faulting, and the helpfulness of systematic sampling than the superintendents of 1869. Moreover, the maps and assay-plans are studied today with an insight undeniably greater and the use of diamond-drills, plus the rapidity of exploration obtainable by the use of machine-drills, has appreciably increased the chances for finding ore. Besides, the mine manager today has learned to watch details of expenditure and to systematize the whole of his highly specialized business in a manner foreign to the easy-going superintendent of a more romantic era.

The one thing that has not changed is Nature: the character of the Lode and the distribution of the ore; that still puzzles the most highly technical. Then, as now, some luck is needed—the luck of the miner. And he is entitled to it, for he takes his chances. Whether much ore has been left in old workings depends upon the definition of 'ore,' that is, how rich it must be to warrant the expense of re-opening. One old-timer told me, apropos of the opening of the Eureka: "If ever they get a mine, they'll have to find it." That is probably true. The gleanings will not suffice. But I believe they will find fresh orebodies. The experience of the Plymouth

is encouraging. That mine was closed down on January 1, 1888; twenty-five years later, in 1913, when the work of re-opening began, the water was running out at the top of the shaft. On August 1, 1914, the new mill began crushing. At the end of March 1916 a million dollars worth of gold had been won at a profit of \$300,000. When the new start was made, the main shaft was down 1660 ft., and the bottom level was at 1600 ft. vertical. A winze had been sunk 70 ft. below this level at a point 75 ft. north of the shaft; this winze averaged \$2 per ton all the way, except at the bottom, where a \$17 sample was obtained when the mine was pumped out. Apparently the bottom had not been sampled by those who worked the mine in 1887 or they had not cleaned up after the last round of holes. Anyway, they appear to have

missed the top of an ore shoot. The winze was sunk 130 ft. in ore averaging \$5.50 for a width of 8 ft. The length of this ore shoot, so far proved, is 300 ft. The shaft is now 2750 ft. deep on the dip or 2230 ft. vertically. When driving on the 1500 ft. level another ore body was cut; this has been traced up to within 875 ft. from the surface; it averages \$7.50 for a width of 12 ft. and for a length so far proved of 320 ft. This is a new asset unknown to the predecessors of Messrs. Albert Burch and W. J. Loring, who are now directing operations. Other chances of finding ore remain. This experience should encourage those who are reopening the Eureka. Horizontal exploration, by drifts and cross cuts, should be an important feature, for that is one of the advantages of a mine having a deep shaft.

Chilean Nitrate

The reported production of nitrate of soda in northern Chile during April was 5,337,592 Spanish quintals of 101.4 lb. each (541,231,929 lb.), while the amount exported to all countries was 4,913,379 quintals (498,275,630 lb.). The production for the same month in 1915 was 1,988,101 quintals and the exports were 2,964,136 quintals, and for 1914, 5,589,542 quintals produced and 4,444,371 quintals exported.

The price of nitrate increased somewhat during April, being quoted at \$1.80 per quintal at the end of the month, free alongside vessel, for the ordinary 95% nitrate and \$1.86 for the refined. The rise is due to a better demand from the United States.

There is not the same tendency to rush production that was evident during the latter part of 1915. The largest Chilean company has closed one of the *oficinas* operated by it, and a number of other *oficinas* will close as soon as they finish producing nitrate already contracted by them. Three *oficinas* owned by the *Compañia Salitrera Alemana*, and shipping through the port of Talta have been forced to shut-down, as no shipments could be made by them, due to lack of sacks. The embargo placed by British authorities tends to prevent German nitrate companies from securing the jute sacks used to ship nitrate. —*Commerce Report*.

Pyrite Production

The domestic production of pyrite in 1915 reached a new high level, due chiefly to the unprecedented demand for the mineral in making sulphuric acid. The output was 394,124 long tons, valued at \$1,671,933, an increase of 57,462 tons in quantity and of \$391,587 in value compared with 1911, according to W. C. Platen, of the U. S. Geological Survey. The consumption of ore, that is, the combined domestic production 394,124 tons, and imports 964,634 tons, was 1,358,758 tons, a decrease of 4521 tons compared with 1911. This decrease is due to a falling-off in imports. The general resumption of activity at acid plants especially created a great demand

for both foreign and domestic pyrite, and the imports, particularly of European pyrite, would have been larger if suitable vessels had been available for the carrying trade.

Costs at the McIntyre Mine, Porcupine

During the year ended March 31, 1916, this property yielded 105,758 tons of gold ore averaging \$7.71 per ton, at the following cost:

Mining:	Per ton	Milling:	Per ton
Labor	\$9.8132	Crushing, etc.	\$9.1029
Supplies	0.3063	Ball-mills	0.1502
Hoisting and tram-		Tub-mills, etc.	0.1721
ming	0.5673	Reagents	0.1405
Timbering	0.1650	Aspirators	0.0187
Rock-drills main-		Thickeners	0.0038
tenance	0.0495	Charilters	0.0209
Air	0.2328	Precipitation	0.1246
Preparing steel	0.1281	Pumping, etc.	0.0111
Track	0.0109	Heating	0.0121
Pulping	0.0273	Refining	0.0512
Assaying	0.0569	Assaying	0.0284
Surveying	0.0127	Superintendence ..	0.0266
Exploitation	0.0726		
Total mining	\$2.5116	Total Milling	\$9.618

The miner does not profit so much as the smelter by an increase in metal prices. The editor of *McIntyre and Chemical Engineer* remarks that at a part of the stopper of lead, silver, and copper concentrate has been received only 52% of the gross market value of the metal contained in the ore, leaving 48% for the smelter. This was when prices for the metals were high. A year previous when metals were at a lower price, the concentrate of about the same grade brought 66% of the gross market value to the miner and 34% to the smelter. One reason for this discrepancy may be that the smelter who prices are high is too busy to take in the concentrates but is desirous to encourage production when metal prices are low, so as to equalize sales and possibly the amount of ore shipped. A smelter should operate as regularly as possible.

Milling Practice at the Santa Gertrudis

By Hugh Rose

*The properties of the company lie within the Pachuca district, State of Hidalgo, Mexico, connected by three railway lines with Mexico City, 55 miles south-west, and by two lines with Vera Cruz, 250 miles south-east.

The ores were formerly divided by sorting into two classes, smelting and milling, the former averaging about 2 oz. gold and 335 oz. silver, the latter 0.12 oz. gold and 23 oz. silver. The smelting ores were sold to custom plants, principally the American Smelting & Refining Co. at Aguascalientes. The milling ores were treated by the patio process at the Guadalupe Hacienda, at Pachuca. This patio was probably the largest in existence at the time and continued in active operation up to March, 1910.

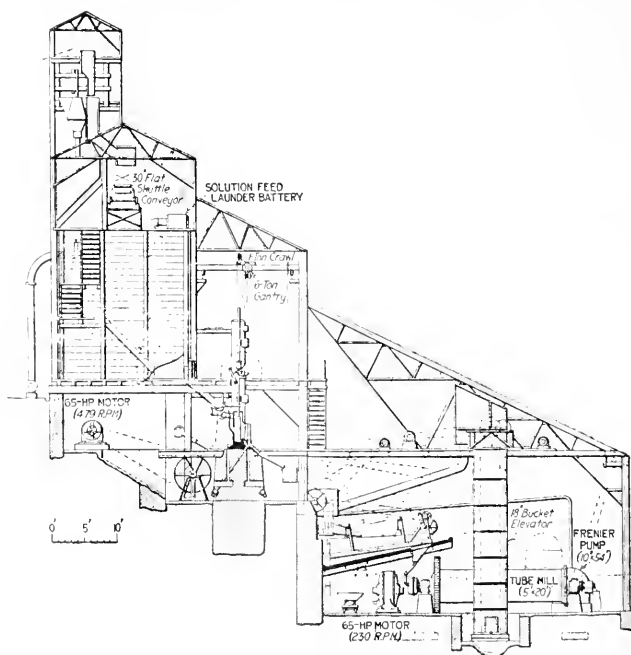
In January, 1910, the mines and patio were sold to English interests, represented by Camp Bird Limited. Two new companies were formed, the Compañía de Santa Gertrudis, to operate the mines, and the Compañía Beneficiadora de Pachuca, to build and operate a custom cyanide-milling plant. The capacity of the plant is 1100 tons per day.

DESIGN OF MILL. The ore-bins of 600 tons capacity feed two No. 6K gyratory crushers, discharging to a double screen 14 ft. long. The oversize from the 4-in. round-hole screen passes by conveyor to the tube-mill storage-bin, while the undersize joins the oversize of the 2-in. round-hole screen for crushing in two No. 4K gyratory crushers. The undersize from the 2-in. screen, together with the discharge from the secondary crushers, is delivered to a 22-in. troughed belt-conveyor, equipped with a Merriek weightometer.

The 22-in. conveyor discharges over the first of three Vezin samplers, a 5% cut being taken and stored in a sample bin of 15 tons capacity. The reject flows to a 30-in. shuttle-type flat-belt conveyor for distribution into bins of 2000 tons capacity. The first sample-cut is fed from the 15-ton bin through a set of 26 by 15-in. rolls reducing to $\frac{3}{4}$ in. and finer, and discharging to a second Vezin sampler cutting out 10%, which is delivered by a revolving Challenge feeder to the third Vezin, taking a 20% cut. A sample of 1 ton is thus obtained for each 1000 tons milled and is crushed to $\frac{1}{4}$ in. in a size F gyratory crusher, thereafter being cut down by Jones

rifles and reduced in the usual manner. Rejects from the second and third Vezin samplers and from the quartering-floor are returned to the battery-bins by an 8-in. elevator.

The ore passes from the battery-bins through Hoseur feeders to sixty 1550-lb. stamps arranged in units of 10 stamps each, 20 stamps being driven by a 65-hp. motor,



SECTIONAL VIEW OF STAMP-MILL.

belted to a jack shaft. The stamps make 102 drops of $7\frac{1}{2}$ in. per minute; 3-mesh and 4-mesh screens are used, the pulp from the batteries flowing through split distributing-launder to six primary duplex Dorr classifiers, the sand passing to six 5 by 16-ft. tube-mills, the discharges from which are delivered to the launder leading to the secondary classifiers by elevator or by reserve 10 by 54-in. Frenier pumps, one pump to each mill. The slime-overflow from the primary classifiers is laundered to eight secondary duplex Dorr classifiers, which feed the sand to four 5 by 20-ft. and two 5 by 22-ft. tube-mills, the discharges from which are returned by elevator or Frenier pumps to the classifiers.

The slime-overflow from the secondary classifiers

*Part of a paper to be read before the September meeting, in Arizona, of the American Institute of Mining Engineers.

passes to six primary Dorr thickening tanks, 35 ft. diam. by 15 ft. deep, wherein the pulp is thickened from 10:1 to 1.5:1.

The thickened pulp is delivered to a set of 11 primary Brown agitators 15 by 45 ft., operating in series; the discharge from the last tank in the series is by means of an air-lift, submerged in the tank itself, and delivering to a launder where a wash of four parts of mill solution is applied, the pulp flowing to four secondary Dorr thickening tanks, 35 by 15 ft., wherein it is again thickened to about 1.75:1 and delivered to a set of 11 secondary Brown agitators, 15 by 45 ft., also operating in series, the discharge from the last tank flowing to two 35 by 12-ft. storage-tanks equipped with mechanical agitators.

These storage-tanks feed, by gravity at 35-lb. pressure, four 90-frame Merrill filter-presses, size of leaf 4 ft. by 6 ft., width of frame 3 in. The tailing sluiced from these presses flows to four 35 by 15-ft. Dorr thickeners for recovery of water before passing to the tailing-storage dams. The pregnant solution is clarified by passing through four sand-filter tanks, 40 ft. diam. by 10 ft. deep.

Precipitation is effected by the Merrill zinc-dust process in two circuits, partial and barren, in order to economize the zinc-dust.

The precipitate is melted in a battery of eight oil-fired No. 400 crucible-furnaces arranged on the arc of a circle and served by a radial jib-crane, fitted with an air-cylinder for raising and lowering the pots.

All pumping of solution and water is concentrated in two pump-houses, one placed below the filter-plant and the other below the precipitation-plant. The pumps are of vertical triplex-plunger types, gear-driven by motors, and are installed so that one pump is in reserve for two circuits.

An electrically operated inclined tramway runs from the top to the bottom of the mill, delivering material to any floor.

Compactness of design was sacrificed in order to secure a gravity-flow. This was permissible owing to an unusually ample mill site of 17 $\frac{1}{2}$ slope, coupled with a mild climate requiring no housing of tanks. Supervision is made easy because the size of the plants warrants the division into two departments, mill and cyanide, and the tramway is used by the bosses in getting round. The mill is electrically driven throughout, 50-cycle alternating current being distributed at 440 volts.

THE CRUSHING-PLANT design exhibits no points of special interest. The elimination of elevator-returns and the favorable character of the ore make the operation unusually easy and simple. Consumption of steel liners, etc., is almost negligible. The 6K gyratory crushers, driven by 30-hp. motors, take only 15 hp. each. This is again due to the character of the ore and the large percentage of fine, which, if the ore had greater abrasive quality, it might pay to screen out beforehand.

An ample supply of mine-rock for use in the tube-mills, in place of pebbles, is obtained cheaply from the

revolving-screen oversize as described above. The Merrick weightometer is checked weekly against a weighed quantity of ore, the average error being well under 1%. Current weightings are corrected by the weekly factor thus obtained.

Particular attention is paid to securing an accurate sample of the ore delivered to the mill. Ordinarily two classes of ore are sampled separately each day. The rejects from these two are thoroughly mixed and quartered down, to make the mixture sample for the day. The calculated average assay of the two class-samples checks closely the assay-results of the mixture. The usual samples are taken for moisture, which averages about 5%.

STAMPING AND TUBE-MILLING. The design of the stamp battery follows standard lines except in a few minor details. The mortar-box foundation-bolts are crossed, as shown in the sketch, thereby permitting a broken bolt to be removed easily; none has broken thus far. A traveling crane, as well as a crawl, installed with the building, was found useful in erecting the battery and in making current repairs.

The stamp-duty averages 21.1 tons through 3-mesh and 4-mesh screens. Crushing is in mill-solution, 10 parts of solution to 1 of ore. Screen wear is of no importance. Steel wear per ton is: Shoes 0.16 lb., dies 0.08 lb., liners 0.60 lb. Life of shoes, 9 $\frac{1}{2}$ in. diam. by 14 in. long, averages 90 days; of dies 97 days; of liners 43 days. Shoes and dies are forged steel. Liners are cast-iron made locally. Manganese-steel liners have been tried, but the cost per ton crushed was considerably higher. The 65 hp. motors, each driving 20 stamps, are overloaded about 8%.

A trial was made of introducing the battery solution through nozzles in the back of the mortar box above the dies, but without success. Stationary screens placed between the feeder and the mortar-box to take out the fine were also tried and abandoned, the benefit being doubtful while requiring more supervision.

Average screen-analyses of feed and discharge of the stamp battery, equipped with 3-mesh, No. 32 wire screens, are:

Inches	Dis-		Inches	Dis-	
	Feed,	charge		Feed,	charge
	%	%		%	%
2	0.5	1.0	10	1.4	4.1
4	18.4	16.3	20	2.2	6.7
6	13.8	11.5	30	2.0	6.2
8	8.0	7.6	40	0.7	2.7
Mesh			50	0.8	3.2
10	18.7	16.3	60	0.4	1.7
20	11.5	10.2	80	0.1	2.7
40	1.8	7.6	100	6.0	21.2
60	8.5	11.8			
80	3.9	8.7		99.5	99.9

Distribution of the pulp from the battery to the primary classifiers by means of split launders could be improved by a mechanical distributor of one of the successful revolving types. The classifier platforms were built on an incline to save head room over the tube-mill

gears as well as to follow the slant of the classifiers. Returns to the classifiers from the tube-mills are by elevators with individual Frenier pumps as reserves. A better design, following later practice, would be to effect such returns by means of the classifiers themselves.

Tube-mill grinding is done in two stages, using 5-ft. mills throughout, the primary series being 16 ft. long and the secondary series 20 ft. and 22 ft. Comparison of this system with single-stage grinding has failed to show conclusive results in its favor, although a slight benefit is apparent. This benefit is, however, insufficient to warrant a repetition of this refinement of design unless in conjunction with water concentration, not required with this ore.

Danish flint pebbles were used for a considerable period, but their increasing cost led to the adoption of mine-rock. A supply is obtained mechanically in the crushing-plant as described and is sent separately over the regular conveyors to a compartment in the battery-bin from which it is transferred by chute to the primary tube-mill floor where it is distributed by ear. Part of the rock is introduced into the mill through the feeder. As the trunnion opening of the mills is not as large as it should be, rocks over 5 in. as well as occasional large boulders, 12 to 15 in., required in the primary mills for efficient grinding, are loaded into the mills through the manholes once per day; 130 lb. of rock is required for each ton of ore milled and is credited to the total tonnage treated.

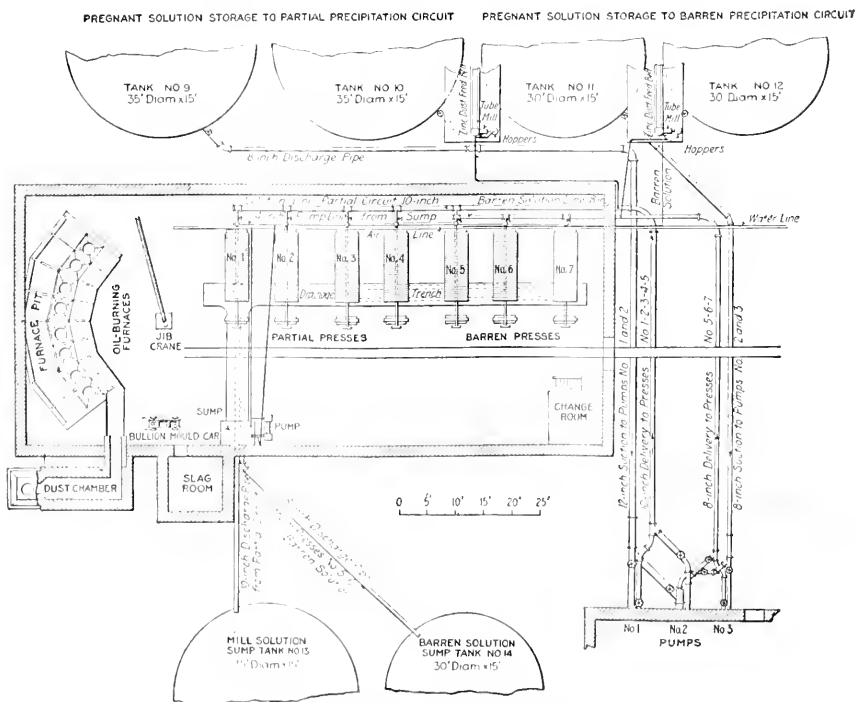
Tests are now in hand using cast-iron balls in place of rock. Results thus far obtained indicate a capacity increase of 33% with finer grinding. Power load shows an increase of 33%, from 65 to 90 hp. per mill. Forged-steel balls ordinarily used for such grinding were not obtainable but it is quite probable that chilled cast-iron or semi-steel balls and liners will prove more economical, taking into account the low cost of locally-made castings, 2.5c. per pound, as against high first-cost plus importation expenses of steel balls. Ball wear is 1.7 lb. per ton milled. Tube-mill liners are of modified El Oro type, of hard cast-iron, the average life being 6 months; cost 2.2c. per ton of ore milled.

The motor driving each mill through a flexible coupling and one reduction of spur gearing is of high-torque induction-type, 65-hp., 230 r.p.m. Allis-Chalmers make. Its ample design easily carries the over-load. But the power factor of this motor is low, 75%, and an improvement would be to use a higher-speed motor with a single reduction of herringbone gearing.

The economical grinding point is taken at 75% through 200-mesh. Screen-tests of feed and discharge of primary and secondary tube-mills, using mine-rock and at a plant-capacity of 1000 tons per day, are as follows:

Moisture, 35 to 40%. Operating without return, 175 tons of ore passes through tube-mill per 24 hours.

Moisture 35 to 40%. Operating with return, in closed circuit, 200 tons of ore passes through mill per 24 hours.



PLAN OF PRECIPITATION AND MELTING ROOM.

Mesh	Primary Feed, %	Tube-mills Discharge, %	Secondary Feed, %	Tube-mills Discharge, %
+ 4	13.9	0.2	0.8	1.6
+ 8	22.8	4.5	0.5	0.1
+ 10	8.6	2.2	0.4	0.2
+ 20	20.6	8.5	1.6	0.2
+ 30	11.8	10.9	3.4	0.7
+ 40	4.7	4.8	3.3	1.0
+ 60	8.0	12.1	17.5	10.8
+ 80	1.9	10.2	9.6	5.6
+ 100	1.6	5.2	11.4	10.3
+ 120	1.5	6.5	17.6	15.5
+ 150	0.7	4.0	9.5	11.8
+ 200	0.8	5.7	8.4	11.2
- 200	2.5	25.0	15.6	30.7
	99.4	99.8	99.6	99.7

SECONDARY CLASSIFIER OVERFLOW
(Finished Product of Mill)

Mesh	%	Mesh	%
+ 100	3.8	+ 200	9.5
+ 120	5.7	- 200	75.1
+ 150	5.5		99.6

AGITATION. An extraction of 55.5% of the gold and 18.6% of the silver is made in the mill before the pulp reaches the Brown agitator system.

Cyanide of sodium, either 128 or 120% as obtainable, in lump or in brick form, is added at the first tank of the primary series, at the rate of 4 gr. sodium cyanide for each gram of silver in the ore delivered to the mill. The sodium cyanide consumed is 3.15 lb. per ton, including mechanical loss. The strength of solution at the beginning of agitation is 0.55% KCN; of the mill solution, 0.4%.

Protective alkalinity is maintained at about 0.75%; the lime, fed dry into the ore at the crushing-plant, is low-grade, averaging about 65% available, the consumption being 20 lb. per ton. Arrangements are in hand to improve the method of feeding by emulsifying the lime, adding it either to the primary tube-mills or to the Brown agitators.

Crude litharge, between 85 and 90% PbO, adopted in place of lead acetate as being both cheaper and more efficient, is ground in a small tube-mill, 24 in. diam. by 37 in. long, discharging into the first Brown agitator at the rate of 0.6 lb. per ton of ore. The best results are obtained with 72 hr. agitation although 60 hr. gives within 2% as high extraction. The air pressure is 27 lb., 75 cu. ft. per minute being required for each tank.

No difficulty has been experienced with the series operation of the Brown agitators. Connections between tanks are made by 10-in. horizontal pipes, placed 3 ft. from the top, the joint between two abutting pipes being made leak-proof by a wrapping of tarred canvas. This joint takes up the tank vibration and effects an easy connection. To avoid undue accumulation of slime on the inside of the tanks, they are emptied and sluiced once a month. This operation requires about 3 hours per tank, using a 3-in. Traylor slime-pump for the return.

Screen-tests of the inflow and outflow of the system

are practically identical, showing that there is no segregation or short-circuiting of sand or slime.

FILLING. This step in the process is difficult, owing to fine grinding of ore containing a considerable amount of colloidal matter. Also, the dissolved metal in the pulp to the filters is high, 3.5 oz. silver per ton of solution. After extended working scale tests of several types of vacuum and pressure filters, Merrill presses were adopted, using the centre system of filling. A press cycle occupies 75 min. made up of

	Min.
Charging	26
Barren solution wash	15
Water wash	13
Sluicing	23
	75

Bristol recording-pressure gauges are attached to the filling pipe of each press, the cycle curves from the chart giving an excellent check upon the care taken by the attendants in operating the presses. The sluice-valve bar and the filling valves are electrically connected so that both cannot be coincidentally opened without ringing an alarm-bell. The cakes average 1½ in. thick, thereby leaving ½ in. space in the centre of the 3-in. frame for entrance of washes. Dry pulp handled per cycle, 11.5 tons. Sluicing water is at 90 lb. pressure and five parts are required to clean out a press. The bulk of this water is recovered in dewatering tanks as explained heretofore.

No. 6 cotton duck, 72 in. wide, is used regularly, after extensive trial of several other weights. A set of cloths lasts about 2500 cycles. Acid washing to remove lime is done in the press every 10 days, using a 0.75% sulphuric acid solution.

Much care is taken with the nozzles of the sluice bar. The bar of each press is taken out and tested every 18 hr., any defective nozzles being replaced. Nozzles are ordinarily ½-in. cast-iron plugs, drilled ¼-in. hole; these last practically as long as special steel nozzles and are much cheaper.

The unwashed metals in the press discharge averages a trace of gold and 0.08 oz. silver, showing an efficiency of 97.7%.

PRECIPITATING. All solutions to be precipitated are first passed through ordinary sand filter tanks. The addition of about 40% by volume of sawdust to the sand considerably improves the clarifying efficiency of the filtering medium and at the same time reduces the frequency of slime-skimming and sand cleaning. The latter operation is effected by shoveling the sand from the tank to a launder leading to a small trommel where the sand is washed free of slime with small loss, and returned for reuse.

In this way, 4500 tons of solution is filtered daily at a cost of 0.28¢ per ton of solution. Possibly Merrill clarifying presses would be an improvement, although no comparative figures are available. At any rate the existing equipment does the work efficiently and cheaply.

The Merrill zinc dust process of precipitation has justified its adoption. Its efficiency, safety, cleanliness,

etc., compared to the zinc-shaving method are too widely known to need further elucidation here. The ease and rapidity with which a clean-up can be made gives it a further special advantage in a good-sized mill treating silver ores with the consequent considerable production of precipitate. Formerly the process enjoyed the advantage of a lower price for zinc-dust than for zinc-shaving; the difference now is practically negligible.

The solution from the sand-filters averages 0.015 oz. gold and 3 oz. silver. Two circuits are maintained, one precipitating to barren solution, sufficient for the filter-press washing, and the other circuit to an effluent containing from 0.9 to 1.2 oz. silver per ton. To accomplish this, a slight excess of zinc-dust is fed to the barren circuit in the proportion of 1.1 oz. zinc-dust to 1.0 oz. fine bullion; to the partial circuit 0.8 to 1.0. The average zinc consumption of the plant is an ounce of zinc for each ounce of fine bullion.

Clean-ups made at the middle and end of the month, and sometimes oftener, provide an accurate check on current work.

MELTING. The only drying of the precipitate is done by blowing air through the presses at 25-lb. pressure for an hour, reducing the contained moisture to about 30%. The precipitate is removed from the presses into rectangular steel cars, 5 ft. 10 in. by 6 ft. 4 in. by 1 ft. deep, in which it is weighed. Based upon the calculated dry weight of the precipitate, flux consisting of $1\frac{1}{2}\%$ each of borax and bottle-glass, is added on top without mixing, and the charge is then shoveled from the car into No. 400 crucibles. To permit the introduction of a high column of precipitate, a discarded pot with the bottom out is temporarily fitted into the crucible, being removed after the charge has melted. This procedure reduces dust losses and accelerates charging and melting.

The eight furnaces are oil-fired, built flush with the floor of the melting-room, on the arc of a circle with fire-pit at the rear. This arrangement has proved satisfactory and is to be recommended as convenient and labor-saving.

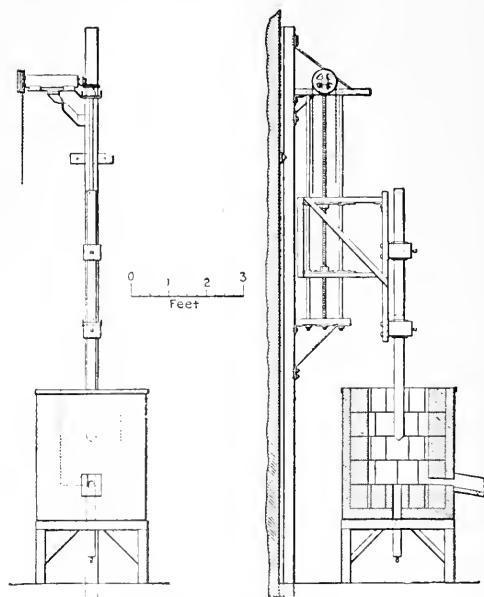
The crucible, upon being lifted from the furnace by tongs attached to $\frac{1}{2}$ -in. wire-cable raised or lowered by air-cylinder on the post of the jib-crane, is swung around to one side to the pouring-carriage containing the bullion-molds. The slag is first skimmed off, using sand. As the bars are poured, sticks of wood are laid on top and, igniting, prevent too rapid cooling of the centre of the bar with the consequent subsidence and holing.

The precipitate averages 85% fine bullion; the Doré bars weigh 1000 oz. and assay 5.0 gold and 940 silver fine. The No. 400 crucibles contain an average of seven bars per melt with a maximum of 10 bars. The average life of a crucible is 10 melts or 70 bars, which may be considered satisfactory.

With bullion of this fineness, no difficulty with matte formation is experienced. The bars are carefully cleaned and all chips and corners removed before sampling and weighing. Drill-samples are taken, one on the top of the bar, one-third the distance along the diagonal toward the

centre, and one on the bottom of the bar at one corner; each hole is drilled half-way through the bar.

Melting the precipitate in an electric furnace, built after the Alaska Treadwell and Lluvia de Oro design, is under trial. Alternating current at 120 volts is used, the input being about 600 amp. working at full heat. Trouble has been experienced with dusting and with burning a hole through the bottom of the furnace; a renewable iron plug may provide a convenient remedy for the latter. The dusting is probably due to the precipi-



ELECTRIC MELTING FURNACE.

tate being wet, the intense heat at the electrode setting up a central draft of steam and air. Either the precipitate should be dried or some dust-collecting apparatus attached to the furnace-top. The advantages of this system over the oil-fired crucible method of melting are rapidity of melting and discontinuance of the use of crucibles and oil, both of which require a long-distance haul.

Exports to the United States during 1915 totaled \$1,778,600,000, which is about the normal amount. Of this, more than one-third came from the British dominions; the next largest contributors were Cuba, Brazil, and Japan. Exports totaled \$3,547,500,000, which is a tremendous increase. Of this nearly one-half was to the British dominions. The next largest customers were France, which took 14%, Italy which took 7%, Russia, Holland, Cuba, and Scandinavia.

BROMINE production of the United States in 1915 was 855,857 lb., worth practically \$1 per lb., an increase of 278,866 lb. and \$653,213 over 1914.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

RAILROADS of the United States consume 24% of the total coal production of the country.

GRASS VALLEY MINES, including Nevada City, yielded \$11.14 in gold and 7 cents in silver, or \$11.21 in both metals per ton in 1915.

ELECTRIC-POWER costs at the mines of the St. Joseph Lead Co. in south-west Missouri, range from 0.55 to 1.56 cents per kilowatt-hour. Gas-producers and gas-engines as well as steam-turbines and Corliss engines are used to generate the power. Coal is cheap in the region.

DWELLINGS owned by the Calumet & Hecla company and rented to employees number over 800, and 1000 other employees own houses on the company's land. The dwellings are piped with clean Lake Superior water, and the company removes all garbage. No stores are on the company's land, but many school-houses are.

AMONG Mother Lode mines the Eagle-Shawmut, in Tuolumne county, is remarkable because 85% of the yield of gold is won from the concentrate by means of chlorination. The concentrate has an average assay-value of \$39.21 per ton. Only 76 cents per ton, or 15% of the total yield, comes from the amalgamating plates.

PIPE-THREADS are cut differently on English pipe and fittings than on those of American manufacture. The number of threads per inch and the shape of the threads are different. Inconvenience frequently occurs at mines in foreign countries where part of the fittings are American and part are English. Care should be taken when ordering supplies in foreign countries to specify which thread is wanted.

RED WRAPPERS for dynamite sticks have been requested by the Alaska Treadwell Gold Mining Co. of the du Pont explosives company. Such wrappers make dynamite more conspicuous when scattered about or in missed holes. The idea was suggested at the Treadwell mine by a miner competing for the quarterly safety-first prize offered by the company, but is not new to the explosives manufacturers.

COST of mining and delivering ore to the mills in the lead district of south-east Missouri averages 85 cents per ton, of which 11c. is paid to miners extracting ore on contract by a per-ton basis. Compressed air for drilling costs 5c. per ton, and explosives 8c.; the cost of keeping roofs and backs safe is 3c. Trimming with mules or power-haulage underground costs 5c. exclusive of track work. Pumping costs 8c., the amount of water raised in the district averaging 12,000 gal. per minute against a head of 500 ft. The cost of diamond drilling and pro-

pecting may add 5 to 15c. to this amount. The output of ore per man for all underground labor is about 5.7 tons per day; that for all employees, including those engaged in mines, mills, and prospecting, is 3 tons per man-day.

HIGH-GRADE spelter is used for galvanizing telegraph and telephone wires that are required to stand sharp bending. If impure spelter is used, it cracks and peels off the wire. Cadmium is especially harmful for such use, as it makes spelter hard and brittle if present in amount of 1 or 2%. Some authorities, however, assert that the high temperature of brass pots causes so much of the cadmium impurity to volatilize that the remainder has little deleterious effect.

SHAFT-SINKING costs of 30 years ago are illustrated by the figure of \$61 per foot for the Tamarack No. 1 shaft at Calumet, Michigan. This vertical shaft was started in February, 1881, and struck the Calumet & Hecla conglomerate lode at 2100 ft. depth on June 20, 1885, 4½ years later. The lowest rate of sinking was 42 ft. per month, and the highest 70 ft. This was in tough solid rock, and uncertainty existed all the time as to whether or not the undertaking would be a success.

SHOVELING machines for loading broken rock into cars underground are being used in mines where the cost of shoveling is high on account of handling a large amount of low-grade ore, such as at the Lake Superior iron mines, and the underground porphyry-copper mines. Several types of mechanical loader are on the market. They are operated by electricity and are as compact as possible to enable working in a narrow drift. A patent has recently been granted to H. H. Talboys of Duluth for a particularly light-weight loader that will permit of easy transportation and have a low first-cost. This loader has no continuously moving parts, but follows the steam-shovel design of requiring motion only when the excavating bucket is doing work. This bucket is actuated by an arm much as on a steam-shovel.

CINNABAR float found on a hillside should be located as a placer, not a lode, claim. The rule is that "if a discovered deposit satisfies the law as to its mineral character, and it is not found in veins of quartz or other rock in place it may be appropriated under laws applicable to placers." ("Lindley on Mines," Sec. 119.) The element of commercial value, its susceptibility of being extracted and marketed at a profit, are the controlling factors in determining the question. It has been held by the Supreme Court of Nevada in *Rogers v. Cooney*, 7 Nevada, 213, that abandoned re-mining that has been suffered to flow and accumulate in vacant and unappropriated public land is subject to placer location. It would seem, therefore, that if in original deposit of this kind can be located as to placers so much the more would the mineral-bearing rock that is reached in its present position be subject to placer location. The being merely the result of a course be not a basis on which to predicate a lode location.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE

In the Broad Pass district there are about 30 prospectors busy, with a number going in. The Government camp at Talkeetna has facilitated transportation. Recently E. Miller and others opened rich silver-lead and copper-gold ore on Ohio creek. This area is expected to develop into an important lode district.

On July 22 the Government held a sale of town lots at An-

chorage. A total of 131 were sold, realizing \$28,740, at prices ranging from \$75 to \$700 each.

In Bulletin 642-F of the U. S. Geological Survey Stephen R. Capps discusses gold mining in the Willow Creek district. Work continued during 1915 on about the same scale as in 1914. The output is derived mainly from the three mines that have been operating for several years, namely, the Alaska Free, Gold Bullion, and Independence. These are equipped with mills, the first two with cyanide-plants, and employ a total of about 120 men during the season. Other mines of the district are the Mabel, Rosenthal, Shough, Jap, Mammoth, and McCoy. Some hydraulic mining was done. The total output in 1915 was \$843,901 gold and \$1828 silver.

CORDOVA

Shipments of copper in ore from Alaskan mines during the first five months of 1916 are as follows, in pounds:

	1916	1915	1914
January	9,365,733	2,149,476	2,784,802
February	10,913,458	3,678,880	1,859,360
March	10,992,707	2,149,272	2,133,980
April	12,992,523	2,845,980	1,319,110
May	12,405,421	3,525,600	603,492

At present the Kennecott company contributes 10,000,000 lb. monthly to the total.

JUNEAU

During July the Alaska Gastineau mill treated 140,043 tons of ore, yielding \$1.24 per ton.

SEWARD

A meeting was held at Seward on August 1 to consider the question of erecting a smelter there. The copper mines tributary to Prince William sound are estimated to contain 1,000,000 tons of ore. The smelter at Tacoma is unable to handle all that is offered.

ARIZONA

COCHISE COUNTY

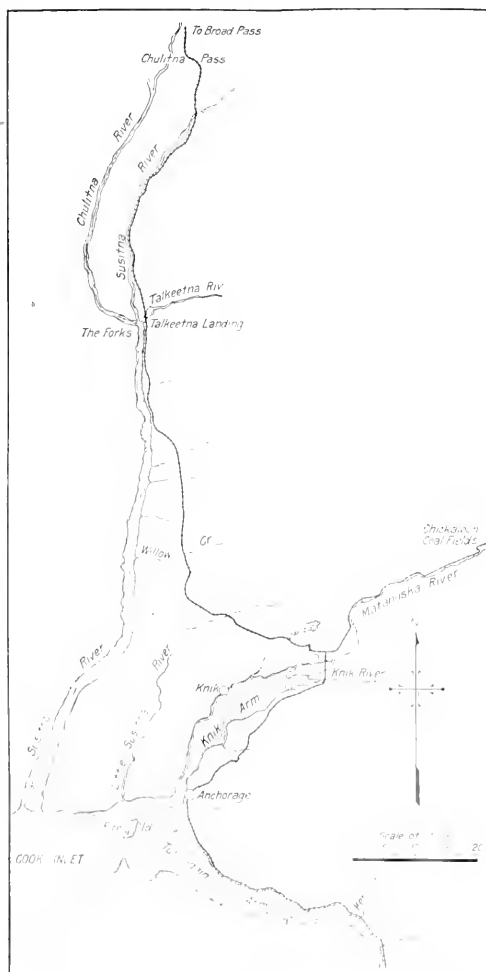
BISBEE. During the second quarter of 1916 the Shattuck-Arizona Copper Co. produced 4,194,873 lb. of copper, 192,459 lb. of lead, 1047 oz. of gold, and 70,350 oz. of silver. The cost was 10.44c. per lb. of copper. Profits were \$689,615, against \$781,380 on the first quarter.

GILA COUNTY

MIAMI. Fifteen miles south-east of Miami, near the properties of the Pandora Copper Co., Arizona Zinc & Lead, Cole Development Co., Independence, Pinal Development Co., Troy & Arizona, Gila Development Co., and Ray Eastern & Whitcher is that of the Greater Miami Copper Co. A fair amount of development has been done, and veins containing gold, silver, copper, and lead exposed. More men are to be employed in charge of N. W. Tanner. Road construction is under way.

On one day last week the Inspiration mill treated 16,900 tons of ore. Steel workers are busy on the extensions. Carpenters are erecting trestles for tailing launders in Warrior canyon.

GLOBE. The North Dominion Copper Mining & Development corporation is being organized by A. Billard and S. Sutherland of Globe to develop the Mercer property at Radium, near Globe. Past work indicates promising results.



OFFICIAL MAP OF PART OF THE RAILROAD UNDER CONSTRUCTION
IN ALASKA.

MOHAVE COUNTY

CHLORIDE. At a depth of 120 ft. in the Schenectady mine rich zinc-silver ore has been opened. It is similar to that at 1400 ft. in the Tennessee.

OATMAN. All kinds of rumors are current concerning the Big Jim mine. Engineers representing various syndicates have been examining the property. A consolidation with adjoining mines is mentioned. The daily output is 30 tons. At 400 ft. the vein assays \$46.36 per ton for the 184 ft. of openings. The 500-ft. level has been opened for 195 ft. Close to the Big Jim shaft the Tom Reed company is sinking a shaft.

The Sunnyside mine, adjoining the Tom Reed, has been financed by Los Angeles people, including Seeley Mudd and John Wuseman, involving \$85,000.

PIMA COUNTY

AJO. The New Cornelia Copper Co. has 750 men employed. Excavation, foundations, and other work at the mill-site is well advanced. Overburden is being removed from the ore-body. Streets, water and sewer systems, and stores at Ajo are making good progress. The town plaza is finished.

YAVAPAI COUNTY

JEROME. It has been hinted by James S. Douglas, president of the United Verde Extension company, that a smelter and other treatment plant are eventually probable. High-grade ore continues to be shipped to smelters. This company is also developing the Jerome-Verde mine from the Extension's 1400-ft. level.

YUMA COUNTY

(Special Correspondence.)—Work on the plants of the Yuma Consolidated and the Plomosa company's is progressing as fast as the great heat and transport delays allow. The Plomosa expects to begin operations not later than September. The Yuma company will have a 2000-yd. and the Plomosa a 1000-yd. plant. At present great interest is being centred on a deep hole on the Yuma ground, the first of its kind in that district, intended to be an experiment and a demonstration of what had been considered heretofore by old-timers to deep to be of much value. This hole, which is 140 ft. deep, has been a revelation. At the surface the gold was rather fine, at various depths rich seams were cut averaging 12 to 20 in. in width, and worth up to \$12 per yard. A hard strata of cement was then penetrated, which also carried finer gold and then the layer of bedrock gravel was met with, which was found to be thick. Of this seam, 15 ft. above bedrock averaged better than \$6.65 per yard, while the whole bed of gravel and cement to the surface yielded over \$2, thus proving that for work in a large way the deeper ground of the district may be found to be even better than the partly worked and shallower ground; the later areas still have ground that will return \$12 per yard.

Regardless of the hot weather many engineers are visiting the district to see the test-plant operating, erected at a cost of \$65,000. Runs were made, the pulverizer and Stedins dry concentrator doing good work, practically 97% of the gold being recovered. A large influx of mining people is expected on the approach of cooler weather, and as a consequence every foot of ground has been covered for 15 miles.

Quartzite, July 31.

CALIFORNIA

BLIND COUNTY

(Special Correspondence.) The Mineral Slide drift mine near Magalia, owned by L. Cohn, J. Gooday, and S. Moody has been bonded by John Cowan and associates of Salt Lake City. C. E. Hand of Los Angeles is in charge. Work has been proceeding steadily during the past month. Twelve men are at work and the old flume and ditch are being repaired. When this work is completed a 1500-ft. bedrock adit will be driven on a sluice-grade to cut the gravel at depth. Mucking ma-

chines will be used and all labor-saving appliances possible. The price fixed on the property is unknown, but is thought to be about \$100,000. This property has produced approximately \$1,000,000 in gold since first opened and is still considered good. Apparatus to save the fine gold and black sand will mean success for this property, as it would with many other drift mines in this State. The present company has the money. Visitors at the Exposition will remember the gold exhibit in the California building. Nearly all the gold in the Butte County exhibit was from the Mineral Slide mine, one nugget being worth \$193. The gold in this property is coarse, and much platinum is found in the black sand.

The Lucky John mine, adjoining the Mineral Slide on the east, owned by J. D. Hubbard and others of San Francisco, has completed the work on a 1000-ft. adit and 96-ft. raise, and will soon be washing gravel. This property is up stream from the Mineral Slide and holds excellent promise to become a steady producer.

Magalia, July 30.

CALAVERAS COUNTY

(Special Correspondence.)—The manager of the Calaveras Copper Co., S. M. Levy, reports that the company is doubling the flotation plant, bringing the capacity to 500 or 600 tons daily. The new installations will include one 8-ft. Hardinge conical ball-mill, a 20-ft. Dorr thickener, 11 pneumatic flotation-cells, and a 11 ft. 6 in. Oliver filter. The flotation process has proved a success here. Concentrate from the old method was never higher than 6 to 8% copper, while the flotation makes a product of 15%, which could be raised to 18%, but would probably result in a greater tailing loss. The new 3-compartment shaft is completed to the sixth level. A new machine-shop has been erected at this shaft, where all repairs for mine and mill may be made. A new rock-crushing plant has been erected near the mill, to be in commission within two weeks. This plant will be capable of crushing 1500 tons of 14-in. and smaller size, in 24 hours. Power is supplied by the Sierra & San Francisco Power Co. Coffey & Trask, lessees in the upper workings of the mine, are producing 10 to 15 tons of shipping ore per day.

A. Wetzel is mining and shipping chrome from W. F. Hendsch and Campbell & Perry's properties near Copperopolis. About 100 tons has been shipped. Rant & Deane of Felix have shipped 60 tons. While there seems to be an abundance of chrome in this area, freight rates, owing to bad roads and distances, make the margin of profit an uncertainty. Mr. Wetzel will soon open a body of manganese ore on the Stack-pole ranch near Milton, and has taken a bond on another manganese property near Bear mountain.

The American Asbestos & Manufacturing Co. of San Francisco is developing a large deposit of asbestos near here. A plant for separating the fibre from the rock is being installed at present. Excavating for the mill is being done with 12 men. A large body of asbestos which can be worked practically as a quarry in benches, is under the control of this company, and as soon as roads and other freight problems are solved there will be a great quantity extracted. J. A. Voorhes is manager of the company.

Copperopolis, August 1.

INYO COUNTY

BISHOP. The new 30-ton mill of the Tungsten Mines Co. is practically complete. Development continues satisfactory.

NEVADA COUNTY

NEVADA CITY. Mining men of the place and Grass Valley have bonded the old Bell mine near Columbia Hill. R. Temeroux, of the Charpen mine at Grass Valley, is in charge.

GRASS VALLEY. At the Allison Ranch mine building construction is well under way, nearly ready to receive machinery. Foundations for the hoist frame are being poured.

and grading has been started for the mill. A water ejector is to be used in unwatering the first part of the shaft. A larger drum has been fitted to the main-shaft hoist of the Brunswick mine.

PLUMAS COUNTY

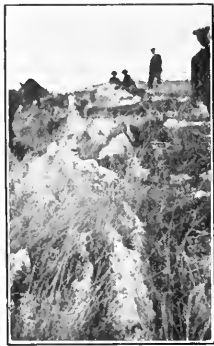
COLFAX. The new mill at the Walker copper mine is practically complete. Assays of the vein in the face of the 1000-ft. adit average 7.14% copper, 3.6 oz. silver, and \$1.20 gold per ton.

SIERRA COUNTY

ALLEGHANY. In the U. S. District Court at San Francisco the Twenty-One Mining Co. is being sued by the Sixteen-to-One Mining Co. for \$100,000 and an injunction, alleging that the Twenty-One is trespassing in the Sixteen-to-One's ground.

TULARE COUNTY

PORTERVILLE. On pages 225 and 234 of this issue will be



OUTCROP AND OPEN-CUT ON MAGNESITE VEIN OF LINDSAY MINING CO., PORTERVILLE, CALIFORNIA.

found some interesting notes on the magnesite situation, directly affecting the Porterville district.

COLORADO

LAKE COUNTY (LEADVILLE)

It has been found that a creek flowing down Evans gulch was pouring into workings of the Harvard shaft of the U. S. S. R. & E. Co., preventing the pumps from draining the ground. At first this was thought to be a natural flow in the mine. This surface water is to be diverted.

The Tarsus shaft on Yankee hill has been repaired to 600-ft. depth. On the bottom level a large vein assaying 89 to 309 oz. of silver and 11 1/2 copper has been found, and promises to be persistent.

The Connors lease at the Ibez last week shipped one ton of ore, yielding gold metallies worth \$2470 on screens, after which is assayed 105 oz. per ton.

OURAY COUNTY

OURAY. The H. A. C. Tunnel & Mining Co. has been incorporated with a capital of 1,000,000 shares at \$1 each, to develop 30 gold-silver claims in the Uncompahgre district, 2 1/2 miles from Ouray. An adit has been driven 800 ft. to cross-cut the property, and in 400 ft. the first large vein is expected, which has a good surface outcrop. Some interesting work is contemplated.

TRILER COUNTY (CRIPPLE CREEK)

The Roosevelt drainage-tunnel is now in 850 ft. east of the Elktion shaft, in breccia formation. A little over 12 ft. is being advanced daily. The flow of water is 11,200 gal. per minute, a decrease of 2500 gal. since July 1.

The July gold yield was as follows:

Plant	Tons	Average Value	Gross Value
Golden Cycle	34,000	\$18.00	\$612,000
Portland	12,000	20.00	240,000
Portland	18,000	2.79	50,220
Portland	14,550	1.92	17,936
Reid-Gold Sovereign	1,350	2.50	3,275
Worcester-Rubie	250	2.90	725
Smelters	4,750	55.00	261,250
Totals	84,900	\$13.96	\$1,185,406

Dividends paid totaled \$210,000, \$90,000 by the Victor, \$90,000 by the Portland, and \$30,000 by the Golden Cycle.

KANSAS

CHEROKEE COUNTY

COLUMBUS. Several farms 5 miles south of this place have been leased to Picher and Commerce, Oklahoma, men, who are to prospect the 1200 acres by drilling. They consider that an extension of the Miami, Oklahoma, field is possible. This marks the third prospecting campaign started recently north of the Oklahoma border. A total of 6000 acres is to be tested by all concerns.

MICHIGAN

THE COPPER COUNTRY

Houghton. It is probable that the Mayflower company will sink a shaft in the near future, although officials do not affirm the rumor. Farmers working on the surface have been told not to plant their next crops. The geology of the property has been studied recently.

An assessment has been made by the Keweenaw. Crushing of ore may start in September.

In connection with the Tamarack mine and G. M. Hyams, several shareholders are to bring suits against him for his interference in the sale of the property to the Calumet & Hecla, whereby they may lose a good deal of money.

MISSOURI

JOPLIN DISTRICT

JOPLIN. On account of the great increase in mining activity in the district the use of natural gas has advanced 25% during the past two years. The Kansas Natural Gas Co. reports that in May of the past three years the consumption was 41,000,000, 55,000,000, and 75,000,000 cu. ft., respectively.

The past week was uneventful in the ore market. The district's output was 4550 tons of blende, 66 tons of calamine, and 954 tons of lead, averaging \$66, \$44, and \$72 per ton, respectively. The total value was \$374,172.

Owing to prices of zinc blende only averaging \$66.30 per ton during July, miners will receive 25c. per day less.

The Ramage No. 6 mill is now ready to treat 1000 tons of ore daily, one of the largest in the district. Wilfley tables, Dorr thickeners, sand rolls, jig, screens, etc., costing \$18,000 were recently installed.

GALENA. The new smelter of the Eagle-Picher Lead Co. commenced operating on July 27. It is thoroughly modern, costing \$100,000. Considerable attention has been devoted to a change-house for employees. John McClaren is manager. Coke from Collinsville, Illinois, is being tried; if successful, it means a large saving over coal.

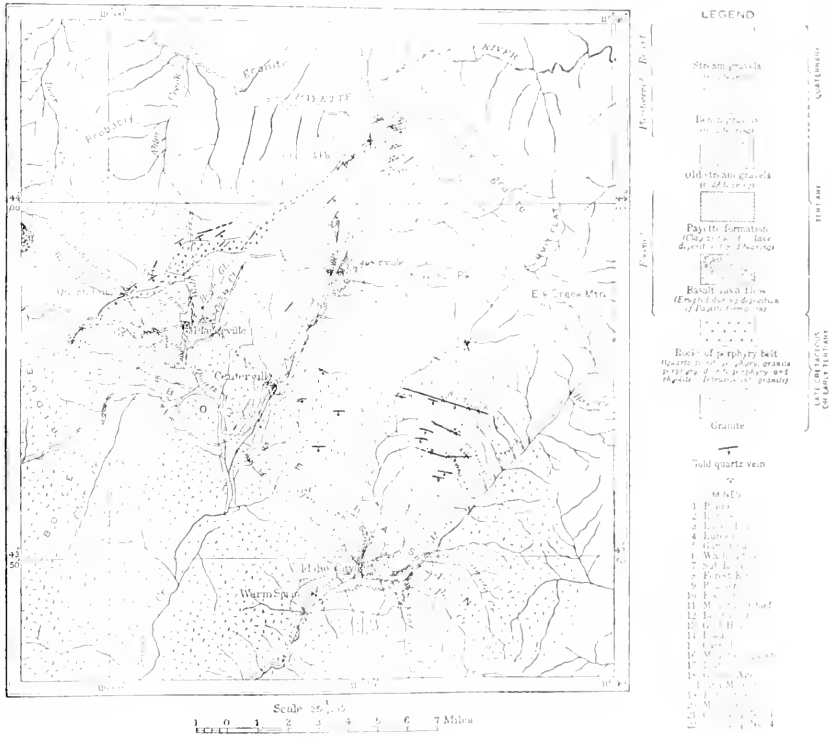
IDAHO

BOISE COUNTY

QUARTZBURG. Lode mining in the Quartzburg and Grimes Pass porphyry belt on Boise Basin is described by E. L. Jones, Jr., in Bulletin 640-E of the U. S. Geological Survey. Idaho City, Centerville, Placerville, Quartzburg, and Pioneerville are

the principal centres of the region. The Basin has a population of 700 people, compared with thousands in the early days. Roads connect the towns. Quartz mining commenced soon after the placers were found. In 1867 there were 10 mills in operation, treating free-milling ores. The refractory ore, now attracting attention, a process having been devised. Gold output of the district from 1863 to 1914 is estimated at \$53,096, 995. Large dredges are now working creek-bed gravels, the yield in 1912, 1913, and 1914 being over \$500,000 per year. Natural conditions are favorable to mining, including timber, sites, water, and power. The future of the area will depend largely on the adoption of suitable treatment for the ores, which are becoming increasingly base. Veins occur in zones of sheeted granite, the Quartzburg and Grimes, and Gambrius belts being the most persistent. Oxidation only ex-

reorganizations at Spokane. A new mill soon to be completed. The Consolidated Interstate Coal Co. reports as follows for the second quarter of 1916: One milled (25.08), zinc, tons 18,000 One and concentrate shipped 18,000 and 48,000 zinc, tons 18,000 Zinc in products, pounds 26,850 Cost of mining, per ton \$1.97 Cost of milling, per ton \$1.49 Profit \$71,675 Compared with the first quarter net earnings were \$60,000 less, yet they were more than sufficient to pay the quarterly dividend of \$1.50 per share. MURRAY. The new mill of the Empire Copper Co. is about



GEOLOGIC MAP OF THE BOISE BASIN, IDAHO.

tends a short depth below the surface. Pyrite and sphalerite are the most widely distributed minerals. The report devotes a good deal of space to notes on the several mines.

IDAHO COUNTY

ELK CITY. H. L. Herkath and others of Spokane have secured a bond for \$15,000 on the Gold Drop claim, six miles away. The mine has been fairly well developed, showing 270 ft. of \$9 gold ore. A 15-ton mill is to be erected.

SHOOSHONE COUNTY (COEUR D'ALENE)

KELLOGG. Lead miners of the Coeur d'Alene received the bonus of \$1 per day for July.

BURKE. The Hecla Mining Co. pays 15¢ per share, or \$10,000, on August 29. This makes \$950,000 for 1916.

The Marsh and Ambergis companies recently completed

the north fork of the Coeur d'Alene river is treated 2,000 tons daily and will soon be into the larger capacity. Concentrate contains 22.5% copper.

WALLACE. In its two years the Hecla mine has now treated 150,000 tons of ore daily. A good deal of ore being shipped direct to smelters. The mine is now developing a new vein of high-grade ore.

HOVAT, IDAHO

IDAHO COUNTY

At the head of the Snake River, at the mouth of the Boise River, the Coeur d'Alene Co. is developing a new vein of high-grade ore. The mine is now developing a new vein of high-grade ore. The mine is now developing a new vein of high-grade ore.

GALLATIN COUNTY

THREE FORKS. Within three months the Three Forks Copper Mining Co., 7 miles north, will be shipping ore. Reserves are considerable down to a depth of 425 feet.

LEWIS AND CLARK COUNTY

HELENA. Claims in the Scratch Gravel and Grass Valley districts are to be developed by the Cruse Consolidated Mining Co., recently formed. R. A. Weisner of Helena is secretary.

SILVERBOW COUNTY (BUTTE)

At 1000 ft. depth in the Butte-Detroit the company is to put in a cross-cut 800 ft. to cut the vein opened on the 500-ft. level. The Ophir mill is to be started early in September.

During the second quarter of 1916 the North Butte Mining Co. treated 146,190 tons of ore, yielding 6,974,742 lb. of copper, 264,400 oz. of silver, and 442 oz. of gold, compared with 131,071 tons, 5,749,193 lb., 244,976 oz., and 365 oz., respectively, in the first quarter. A good vein was cut in July, 15 ft. below the 3500-ft. level in the Granite Mountain shaft, 500 ft. below the present deepest working level.

Owing to the lower price of copper in July, wages at Butte have been reduced from \$4.50 to \$4.25 per day.

The 2000-ton zinc-ore concentrating plant of the Anaconda was expected to start work on August 5, also the electrolytic zinc refinery at Great Falls on the 10th.

According to the manager, W. L. Creden, the Davis-Daly gives most hopeful indications of ultimately developing into a sizable and profitable mine. Prospects lie on the Hesperus orebody, which has been definitely found on the 2500-ft. level. At this point the orebody has been opened for 450 ft., with an average width of 12 ft., the ore assaying between 5 and 7% copper. The breast of the drift on this level is still in ore. Development of this orebody contemplates openings above and below 2500 ft. and to this end a drift is also being put in on the 2400-ft. level, where it is expected that the vein will be encountered in about two months. The new hoist should be in commission about October 1, at which time production should be doubled from the present total of about 135 tons per day. There is, however, no attempt being made at present to extract ore except that which is met with in development. The aim is to keep income and expenditure balanced pending the time when the Hesperus orebody has been developed to a point where a substantial tonnage of ore can be economically mined. With copper at its present prices it is calculated that the Hesperus will easily pay for its own development. Aside from the favorable showing in the Hesperus, Davis-Daly has an asset of potential value in its Hibernia claim, next to the Nettie which the Anaconda company is developing as a zinc mine. No work is being done on the Hibernia at present.

At 500 ft. in the Butte & Great Falls mine a heavy flow of water has necessitated installing a 500-gal. pump and 100-hp. motor. The Dewey vein is close at hand.

NEVADA

ELKO COUNTY

(Special Correspondence.)—The following notes cover the Gold Circle district:

The Gold Circle Queen is being opened by lessees. So far they have milled 200 tons, mostly through a two-stamp mill. Some was crushed at the Elko Prince, but the haul to the latter mill is expensive and the service decidedly unsatisfactory. The lessees announce that they have secured a lease on the Rex five-stamp mill, and will haul the best of their ore there. The gold is generally very fine, but is readily amalgamable. The Rex is equipped with a modern cyanide plant, the stamps being followed by a tube-mill, but it is not known whether the lessees will attempt to make use of it. The ore-shoot developed in the Queen is a little over 80 ft. long, and varies from 1 to 8 ft. in width. Four feet of this, in the north

drift, assays \$50. The whole shoot, as far as developed, would be first-class mill ore if a plant were on the ground.

Early in July the Elko Prince company sent out nearly 1300 lb. of bullion, the June clean-up. No information as to its value is available, but it is estimated locally at \$70,000. Recently the Prince completed the cross-cut to a parallel vein on the June Bell claim. It has proved to be of good milling grade, resulting in the addition of a substantial supply for the mill, and a rise in Elko Prince shares, which are now around 40 cents.

On the Gold Circle group, Randall brothers have opened a shoot of high-grade ore for 20 ft. The vein is from 15 to 18 in. wide, with an additional 24 in. worth \$12 to \$15. Silver has predominated so far, but the gold-content is increasing with depth. This strike brings a new section of the district into prominence. Bamberger's \$10,000 pocket on the Midas ground is not far from the Randall find, but the Bamberger strike had become ancient history, and many of the newcomers were inclined to become skeptical as to the existence of rich ore. So this latest find comes at an opportune time. Lessees would be all over this ground if there were adequate milling facilities close at hand. The Prince mill is in an out of the way place and has a monopoly of the custom business at present. There should be more here.

Noble and Stone have completed their road to the Lucky Boy shaft on the Grizzly group, and will begin hauling ore to either the Prince or Rex mill.—Lessees on the Missing Link claim are mining some shipping ore, and have a fair tonnage of mill ore on the dump.

Midas, July 31.

ELKO COUNTY

(Special Correspondence.)—An experimental plant, costing about \$50,000, is being erected one mile south of Elko for the extraction of gasoline from the immense beds of shale in this neighborhood. Tests indicate each ton of shale will yield approximately 200 lb. of paraffin. The project is financed by R. M. Catlin of New York.

The Tobar zinc mines at Tobar, a new town 80 miles from Elko, are being operated by the Nevada Zinc Co. It is stated that enough ore, much of it high grade, is opened to warrant building a smelter, and officials of the company recently inspected the new plant of the Anaconda company in Montana.

Salt Lake City people are vigorously developing the Clipper mine south of Tecoma. The ore contains a good deal of silver and lead, with traces of gold. In sinking the main shaft, now 90 ft deep, there is still ore in the bottom. From the 80-ft. point driving is under way and small shipments of ore are going to Utah smelters. The group comprises six claims, situated between the Tecoma and Copper Mountain mines, both noted early-day producers.

Elko, August 6.

ESMERALDA COUNTY

GOLDFIELD. The estimated production of the Goldfield Consolidated during July is \$183,600 from 26,700 tons of ore. The profit is \$30,000. During June net costs were \$5.11 per ton. The second section of the mill should be converted to flotation by August 15.

CUPRITE. Thirteen miles south of Goldfield the Los Angeles Sulphur Co. owns large deposits of sulphur, recent shipments being paid for on a basis of 75% pure sulphur. A camp is being erected for employees, and a contract has been arranged for 250 tons of ore per month. A. W. L. Dunn, with headquarters at Goldfield, is in charge. Sulphur is worth \$30 to \$32 per ton in San Francisco.

HUMBOLDT COUNTY

(Special Correspondence.)—News has been brought to Winnemucca of an important copper discovery in the Jackson mountains, about 32 miles from Jungo, a station on the Western Pacific railway. According to the reports of miners there

are two distinct copper-bearing lodes in a monzonite formation, traceable for 12,000 ft. with a width of 1800 ft. One vein contains carbonate, the other consists of sulphides. Assays range from 1 to 15% copper. Arrangements have been made to ship the best ore to Jungo by mule-teams, and negotiations are proceeding for the building of a 50-ton plant.

The new 20-stamp mill at the Kramer Hill gold mine, two miles from Golconda, has been tested and is ready to start crushing. A large reserve of good-grade ore is exposed.

Work has been resumed at the Adelaide copper mine in the Gold Run district, 12 miles south of Golconda. Several buildings are under construction and mine workings are being placed in shape for a large output. The property was recently acquired by John G. Kirchen and associates of Tonopah. Charles Kirchen is superintendent.

Walker brothers of Salt Lake City have taken an option on the Granite Creek tungsten mine, 20 miles north-west of Golconda, and started work. The orebody in places ranges from 20 to 50 ft. wide, and assays from 1 to 20% tungstic acid. The mine is owned by G. W. Carty, P. V. Sanders, Carl Stoffelt, and George Farris.

The Hatch lease has completed the tramway from the Buckskin National to the mill, and construction of the plant is proceeding rapidly. Development continues highly pleasing. The Gayer & Defenbaugh lease has driven its adit 90 ft., and expects to intersect the Buckskin National vein within 80 ft. This lease has also started work on a block of ground in the Buckskin Mary.

Golconda, August 5.

LINCOLN COUNTY

PROCE. On September 1 the Prince Consolidated pays 5c. per share, equal to \$50,000. The gross yield for the first quarter of 1916 was \$294,643. The output of ore is 12,000 tons monthly. The new tailing-treatment plant at Bullionville is at work.

Development in the Hamburg mines near-by is reported to be improving. Thirteen cars of ore have been shipped, netting \$15 per ton. Machinery is to be installed.

NYE COUNTY

(Special Correspondence).—The Ralston Mining Co., recently formed with 1,000,000 shares, has acquired control of the K. C. group, adjoining the East End mine, for a reported consideration of \$18,000. The ground is east of the Halifax mine. It is stated that extensive work will be started shortly, and considerable machinery installed. Charles E. Perry is president; William Foreman, vice-president; T. A. MacDuff, secretary-treasurer, with J. H. Evans and R. J. Highland, directors.

Tonopah, July 31.

TOSORAN. Last week's output of 10 mines at Tonopah amounted to 9662 tons valued at \$199,996.—From its final clean-up for July the West End shipped 67,388 oz. of bullion. —The Extension has resumed development, after 60 days' idleness, in the Victor mine. At \$60, 1140, and 1200 ft. in the Sand Grass claim, the Tonopah Mining Co. is doing considerable work. A large new hoist is to be erected at the shaft.

WHEELING PLATE COUNTY

(Special Correspondence.) The Nevada Consolidated will average 12,000 tons per day during August, of a better grade than usual, just under 25 copper. On the surface of the Ruth mine, the company is mining some 50 and over carbonate ore, which is found by opening some of the iron-quartz veins, wherever carbonate stain is found. A considerable tonnage is being obtained in this manner, part going to the McGill plant for direct use in the converters for its silica content, and part to Utah smelters. Work has been commenced to increase the crushing capacity, all material having been ordered. Some of the Wilfley tables are being double-decked to take care of the increased tonnage.

The Consolidated Copper Mining and Smelting Co. has four drills at work.

The tungsten industry is quiet. The Independent company, after spending about \$100,000 on a complete plant, has shut down indefinitely. The Consolidated Tungsten Co., just south of the U. S. T. Co., has also closed. The Nevada Scheelite Co. (Minerva property) is mining and selling some ore to the U. S. T. Co.—Tilford brothers are running the two stamp mill, selling the product to the same company. It is expected that the U. S. T. Co. will have to close as soon as its present contract with the Midvale Steel Co. expires. Present prices are too low.—The Tungsten M. & M. Co. is running steadily, and making a high-grade concentrate. The company has large ore-bodies, cheaply mined, and it can make a profit at present prices. Some property in this vicinity has been bonded recently, the principals being unknown.

Ely, August 1.

NEW MEXICO

Socorro County

(Special Correspondence).—The Socorro Mining & Milling Co. produced 19 bars of gold and silver bullion and a large quantity of concentrate during the first half of July.

Delivery of machinery for the hydro-electric power-plant of the Socorro Power & Lumber Co. has been promised early in January, and it is now thought that the plant will be in commission by April. It is designed to generate 250 horse-power.

M. L. Nanqu, operating a fleet of oil and freight trucks between Silver City and Mogollon, reports a loaded truck-mile cost of \$0.341, based on a total of 5236 truck-miles and an average load of 6500 lb. It is divided as follows: repairs, gas and lubricating oil, \$0.023; tires, \$0.028; labor, \$0.062. The average mileage per set of tires was 1396. The grades exceed 2% for short distances in a number of places.

The proposed road from Clifton, Arizona, to Mogollon is again receiving consideration. It is understood that the Arizona factors will construct a first-class highway to the State line, and the Mogollon interests are now surveying from the Silver City road at Cactus Flats to determine the feasibility of the route. It is said the distance to railroad would thus be shortened by 20 miles with a reduction of \$5 per ton in freight charges. As the in-and-out freight for this district amounts to many thousand tons yearly, the saving would be appreciable.

Mogollon, August 1.

OKLAMOYU

Orlowski Company

COMMERCE. The Croesus and Bethel, each of 200-ton capacity in 10 hours, three miles north of this place, have made their initial 'turn-ins' of concentrate. Miami people control the properties.

In the Oklahoma field the Lehigh & Zinc Co. is to employ 50 drills in prospecting its 3000 acres of land near Picher.

SOUTH DAKOTA

$$L_{\infty}^{\infty}(\mathbb{N}; \mathbb{R}) \cong C^*(\mathbb{N}) \cong \ell_{\infty}(\mathbb{N})$$

FERRON. At the Works No. 1, etc., in addition to mining 500 to 600 lb. of wolfram daily, the mill is supplied with 250 tons of gold ore each year or ten.

(T.M.)

11. (C)

There is a thin line between the two. The difference is a total of 100,000 barrels a day, or the equivalent of about one-third of U.S. oil production. The difference is collected with 173 cents per barrel, or 1.73 dollars per barrel. The difference is 173 million dollars a day. The difference is 62 billion dollars a year.

and determined by the following equation: $\text{Ea}(\text{kJ mol}^{-1}) = 10.5 \log A - 16.1$ (Shen et al., 1997).

20 ft. of ore worth from \$20 to \$50 per ton. The daily output from the mine is 50 tons.

EUREKA. The superintendent of the Chief Consolidated Mining Co., Cecil Fitch, reports as follows for the first half of 1916:

Development, feet	9,692
Ore shipped, tons	42,144
Gross value per ton	\$30.08
Net profit	\$355,702

The ore averaged 0.124 oz. gold, 20.02 oz. silver, 11.79% lead (on lead ore), 1.95% copper (on copper ore), and 30.36% zinc (on zinc ore). Flat deposits between 600 and 800 ft. yielded a considerable part of the output. A new 'system' of ore has been developed at 1800 ft. Dividends absorbed \$88,182. The balance is \$381,589. At present production is curtailed owing to ore congestion at smelters.

It seems that the smelter situation in Utah is improving, and in a short time the Tintic district mines will be able to market their normal quantity of ore. Generally the district is prosperous.

PIUTE COUNTY

MARYSVILLE. Grading for the new potash plant of the Florence Mining & Milling Co. is progressing on a ranch south of the D. & R. G. railway depot.

The Log Cabin mining district is 11,000 ft. above sea-level, and almost above timberline.

SALT LAKE COUNTY

ALTA. On August 10 the South Hecla company distributes \$40,000, its initial dividend. The daily output of ore is 50 tons. Machine-drills are being installed. Power drills are being increasingly used in the Cottonwood districts, replacing the 'single-jacker' and hand work.

BINGHAM. The Bingham Coalition Mines Co., a new Boston concern, represented by G. A. Packard, has taken over the Utah Development, Massasoit, and Butler Liberal claims, also the Markham mill. The properties are fairly well equipped and developed. Lessees have made good profits in the past.

Owing to lower prices prevailing for copper, employees at the Utah Copper Co.'s mills had their wages reduced 25c. per day last week.

SUMMIT COUNTY

During July the Park City mines shipped 7780 tons of ore and concentrate worth \$350,000. About a dozen properties contributed.

WASHINGTON

OKANOGAN COUNTY

CHESAW. The British Columbia Copper Co. has taken a 24 months' bond on the Ramshorn and Cariboo mining claims on Copper mountain, five miles north-east of Chesaw. The mine is to be opened at once. A tramway to carry ore from the property to the Great Northern line, a distance of over 4 miles, is contemplated.

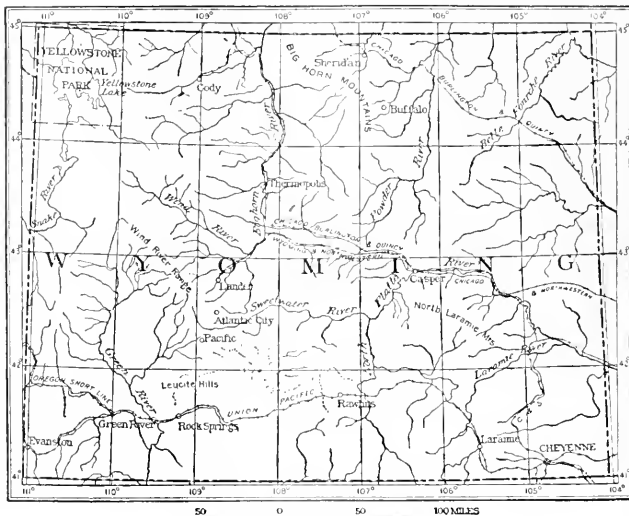
STEVENS COUNTY

CHEWILAH. The United Copper mine is producing 300 tons of ore daily, soon to be increased to 400 tons. Tailings is to be re-treated. A motor-truck and trailer carries ore and concentrate to the railroad.

WYOMING

In Bulletin 626 of the U. S. Geological Survey, the Atlantic gold district and the north Laramie mountains of Fremont, Converse, and Albany counties, are described by Arthur C. Spencer. With maps the publication covers 85 pages. Eleva-

tion of the Atlantic district is 7683 ft. It is 25 miles from a railway. Rocks are crystalline schists, in layers with north-east strikes and steep dips. Diorite intrusions are most abundant. Placer gold was discovered in the Sweetwater district in 1842. Small stamp-mills—12 with 161 stamps—were erected to crush the gold quartz by 1871. It is estimated that to 1911 placers yielded \$1,725,000, and lode mines \$4,137,000. The bullion is 850 fine. According to the State geologist, L. W. Trumbull, the veins are found in the schists, diorite, andesite, and in one case, in granite. On account of lack of near-by rail transport the immediate outlook for a general



MAP OF WYOMING.

revival is not encouraging. The veins are considered to persist in depth. Development, ore treatment, transport, and cost of power are the main considerations for success here. Most of the alluvial gold has been won by working in a small way. Recent production has been small and sporadic. The small gravel deposits offer little promise for the future.

In the north Laramie mountains there has been a search for copper ore, but the prospects opened so far do not seem encouraging. Chromite, magnetite, and asbestos occur, but not in large quantities. Details are given of some of the properties developed.

CROOK COUNTY

BEAR LODGE. The Warner Peak Mining Co. has resumed work in this district. The 5-stamp mill will be used to test the value of the ore.

CANADA

BRITISH COLUMBIA

On August 15 the Rambler-Cariboo Mining Co. pays 1c. per share, equal to \$17,500. This makes \$70,000 for the current year.

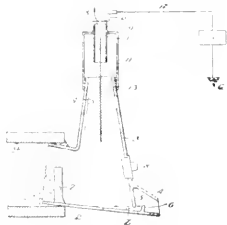
ONTARIO

PORTFOLIO. Good progress is reported on stamp-mill and cyanide-plant foundations at the Hollinger.

A report on the reserves of the Dome Lake mine by the manager, G. G. Thomas, shows that the total is \$2,600 tons worth \$1,246,500, to a depth of 600 ft. Indications point to persistence below the bottom level. The shaft is to be sunk to 600 ft. The enlarged mill will treat 200 tons daily.

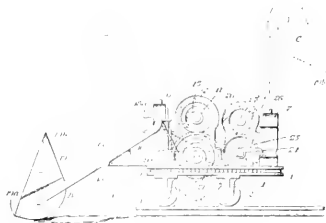
Recent Patents

1,189,830. METALLURGY. Henry Swift Kimball, St. Louis, Mo., assignor to American Zinc Lead & Smelting Company, Boston, Mass., a Corporation of Maine. Filed Feb. 4, 1914.



1. The method of promoting and insuring liquefaction by condensation of a metal from a gas thereof, which consists in subjecting the metallic gas when at or near the temperature of condensation, to a field of electric stress, thereby accelerating the agglomeration of liquefying particles and preventing individual oxidation thereof.

1,186,617. EXCAVATING AND LOADING MACHINE. Henry H. Tatboys, Duluth, Minn., assignor of one-third to Alexander M. Gow and one-third to Stacy H. Hill, Duluth, Minn. Filed Feb. 10, 1914. Serial No. 817,774.



1. An excavating and loading machine, including a supporting frame, a transverse shaft journaled thereon, a vertically swinging hoisting arm rigid with the shaft and carrying a dipper, a wheel loose on the transverse shaft, an operative connection between the wheel and the dipper, counter-shafts journaled upon the supporting frame and arranged parallel to the transverse shaft, gearing positively connecting one of the counter-shafts and the hoisting arm, gearing positively connecting the other counter-shaft and the wheel, and independent motors geared to the respective counter-shafts for simultaneously swinging the hoisting arm and dipper to impart a crowding movement to the dipper and swing the hoisting arm upwardly and rearwardly to discharge at the rear of the machine.

1,188,705. PROCESS FOR THE RECOVERY OF METALS FROM ORES AND THE LIKE. Charles S. Vadner, Butte, Mont. Filed Feb. 14, 1916.

1. The process which consists in recovering manganese and other metals from naturally oxidized or sufficiently roasted sulfid ores containing manganese and other metals by spraying the finely ground pulp of said ores into sulfuric fumes containing sulfurous gases, oxidizing the solution and riddling the solution of other metals contained therein by precipitating same from the cold solution by means of a sufficient quantity of finely pulverized calcium carbonate and recovering the manganese.

Personal

Note: The Editor makes no claim for the accuracy of the notices and appointments.

GEO. WALKINS EVANS, of Seattle, at Chicago.
ALFRED F. MAIN, manager of the E. O. O. P. M. Co., at Chicago.
JAY A. CAMPBELL is on a vacation at South Lake Tahoe.
ROBERT S. ROSE, of New Haven, has returned from Honolulu.
F. W. BRADLEY leaves for Treadwell, Alaska, on the C. O. O. O. O.
HARRY J. SHEAVY is mine superintendent at Mojave, California.

NOLI CUNNINGHAM has moved his office to 200 Fifth Avenue, New York.

G. C. RAY, who has been doing military duty at Monterey, has returned to Oatman.

R. S. BORDEN left Los Angeles for Guadalajara en way to Eagle Pass, on August 7.

R. R. LITTLE, manager of the Butters Division, has sailed for Salvador on August 8.

C. R. KRYES, of Des Moines, has been in Nevada and is now on his way to British Columbia.

FRANK S. BATHUR has been appointed manager to the Baker Mines Co., at Cornucopia, Oregon.

VAN H. MANNING, director of the U. S. Bureau of Mines, is expected here on the 15th instant.

J. O. CLIFTON, of Salt Lake City, has been in the South-West and passed through San Francisco.

D. C. JACKLING has been elected to the directorate of the American Zinc, Lead & Smelting Co.

P. A. ROBBINS has been appointed managing director of the Hollinger Consolidated Gold Mines of Porcupine.

JOSEPH F. THORNTON, consulting engineer to Charles Butters, has arrived from Salvador and gone to New York.

FRED. S. NORMAN, superintendent of mines for the British Columbia Copper Co., has been taking a holiday in Michigan.

FRED SLARLES, JR., and GEORGE SWARTZ left on August 7 for Vancouver, from where they sail in the *Empress of Russia* for China.

BEN HUGHES, editor of the *Northern Miner* at Cobalt, has enlisted in the British forces. RICHARD PRINCE of Toronto succeeds him as editor.

J. W. BOYLE, manager of the Canadian Klondike company at Dawson, is in London. His son, J. W. BOYLE, JR., is in charge of the dredging operations.

R. CHESTER TURNER of the Brunswick Consolidated, Grass Valley, fell 60 ft. in an automobile near Colfax on August 5, but luckily only bruised his knees.

HENRY JENNINGS, THOS. R. SUMMERS, R. A. F. PETERSON, and JOHN B. FARRIS are attending the mas of the Bohemian club, of which EDWARD BENJAMIN is president this year.

Obituary

EDWARD FORGER THORNTON died at Berkeley on August 6 at the age of 73. He was a native of the State of New York and a graduate of Yale in 1868. After graduation he came to California and during his long and honorable career took a leading part in the mining industry, along the Mother Lode. In 1885 he joined A. D. Day & McNamee in opening the Canyon mine in Calaveras county. Later he became one of the best controllers of the property in Amador county. He was a partner in the El Dorado copper mine and was manager for several years in the development of the Central copper at Buena Vista, Amador county. His many affairs and mining operations showed that he was a successful and a keen desire for profit leading. He is survived by a wife and five children.

THE METAL MARKET

METAL PRICES

San Francisco, August 8.

Antimony, cents per pound.....	13
Electrolytic copper, cents per pound.....	27.50
Pig lead, cents per pound.....	6.25-7.25
Platinum: soft metal, per ounce.....	\$60
Platinum: hard metal, 10% iridium, per ounce.....	\$65
Quicksilver: per flask of 75 lb.....	\$75
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, August 8.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$0.75
Chrome: 40% and over, f.o.b. cars California, per ton.....	13.00-16.00
Manganese: 50% product, f.o.b. cars California, ton.....	12.00-16.00
Magnesium: crude, per ton.....	7.00-9.00
Molybdenum: 50% and over, per pound.....	0.60-1.15
Tungsten: 60% WO ₃ , per unit.....	20.00

At Boulder, Colorado, the Primos Chemical Co. has made a new scale for its tungsten lessees, who were paid \$12 to \$20 per unit. Ore containing from 3 to 32% WO₃ is to receive \$8 per unit, plus 25c. for each 1% above the 32%.

New York, August 2.

Antimony: The market is uncertain, and business difficult, in view of the situation in the metal. The nominal quotation is \$1.25 to \$1.50 per unit.

Tungsten: Buyers and sellers are still far apart. It is reported that one company declined to accept \$27.50 per unit for high-class scheelite, holding for \$30. Small lots are said to have sold in the West as low as \$20 per unit, but these sales involve only hundreds of pounds, not tons. Large quantities could not be purchased at that figure. The market for ferro-tungsten is quiet at around \$5 per pound of contained tungsten. Near June 1 it was quoted at \$7 to \$8.

EASTERN METAL MARKET

(By wire from New York.)

August 8.—It is reported that copper is being bought for export; lead is dull and easy; spelter is dull and weak.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Aug. 2.....	64.00
" 3.....	64.75
" 4.....	64.87
" 5.....	66.12
" 6 Sunday.....	65.87
" 7.....	65.77
" 8.....	66.25
Aug. 2.....	65.49
" 3.....	65.16
" 4.....	62.02
" 5.....	62.41
" 6 Sunday.....	62.97
" 7.....	62.71
" 8.....	63.31

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	Aug.	54.25
Feb.	57.53	48.45	56.74	Sept.	53.75
Mch.	58.91	50.61	57.89	Oct.	51.12
Apr.	58.52	50.25	56.47	Nov.	49.12
May	58.21	49.87	54.27	Dec.	49.27
June	56.13	49.03	55.94		55.34

The past week's prices seem to indicate speculation, with a firm undertone. China has been a factor for some time, and is expected to continue so. The moratorium proclaimed in that country may result in silver moving to the Treaty Ports; then sales to India and London. The permanent currency requirements of the country must also be considered. Shipments of silver from London to India up to July 19 total £1,052,500, against £2,810,000 in this period of 1915.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Aug. 2.....	26.00
" 3.....	25.50
" 4.....	25.00
" 5.....	25.00
" 6 Sunday.....	25.00
" 7.....	25.50
" 8.....	25.50
June 27.....	27.25
July 4.....	26.51
" 11.....	26.25
" 18.....	25.49
" 25.....	25.00
Aug. 1.....	25.75
" 8.....	25.58

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26
Feb.	14.46	14.33	26.82	Aug.	12.34
Mch.	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.02	Oct.	11.10
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.47	Dec.	12.75

June outputs were as follows: Chino, 7,243,618 lb.; Nevada Con., 8,651,722 lb.; Ray, 6,598,594 lb.; Utah Copper, 17,877,432 lb., all large increases over May. Also Miami, 4,305,000 lb.; Shannon, 666,000 lb.; Anaconda, 28,200,000 lb.; and Inspiration, 11,300,000 pounds.

On August 1 the United Verde paid two dividends of 75c. each, making \$8.25 per share for the year so far.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Aug. 2.....	6.10
" 3.....	6.09
" 4.....	5.95
" 5.....	5.95
" 6 Sunday.....	5.95
" 7.....	5.95
" 8.....	5.95
June 27.....	6.78
July 4.....	6.84
" 11.....	6.45
" 18.....	6.39
" 25.....	6.20
Aug. 1.....	6.20
" 8.....	5.98

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
Mch.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Aug. 2.....	9.25
" 3.....	8.75
" 4.....	8.62
" 5.....	8.50
" 6 Sunday.....	8.50
" 7.....	8.50
" 8.....	8.50
June 27.....	12.12
July 4.....	11.40
" 11.....	9.75
" 18.....	9.06
" 25.....	9.91
Aug. 1.....	10.12
" 8.....	8.69

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mch.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	16.01	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

Zinc ore prices at Joplin during July averaged \$66.30 per ton, basis of 60% metal.

In the quarter ended June 30 the New Jersey Zinc Co.'s net income was \$8,735,292, of which \$6,650,000 was distributed. The earnings were an increase of \$288,907 above those of the March quarter.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date.	July 25.....	Aug. 1.....
July 11.....	\$3.00	\$3.00
" 18.....	\$3.00	\$3.00
" 25.....	\$3.00	\$3.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	22.00	July	37.50
Feb.	39.00	60.00	25.00	Aug.	30.00
Mch.	39.00	78.00	21.00	Sept.	37.25
Apr.	39.00	77.50	11.00	Oct.	33.00
May	39.00	75.00	9.00	Nov.	33.50
June	38.60	90.00	71.70	Dec.	33.00

TIN

Prices in New York, in cents per pound.

Date.	Average week ending
Aug. 2.....	26.00
" 3.....	25.50
" 4.....	25.00
" 5.....	25.00
" 6 Sunday.....	25.00
" 7.....	25.50
" 8.....	25.50
June 27.....	27.25
July 4.....	26.51
" 11.....	26.25
" 18.....	25.49
" 25.....	25.00
Aug. 1.....	25.75
" 8.....	25.58

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.10	11.76	July	37.50
Feb.	37.56	37.23	12.60	Aug.	30.29
Mch.	38.10	48.76	50.50	Sept.	33.10
Apr.	36.10	48.25	51.49	Oct.	30.40
May	33.29	39.38	49.70	Nov.	33.51
June	30.72	46.26	42.07	Dec.	33.60

Eastern Metal Market

New York, August 2.

The best showing made last week was in lead, for which there was an active demand for carload lots to be delivered promptly—an indication that consumers' reserve stocks are low. Prices, however, declined, and there is still a feeling that the market must come down to start any heavy movement.

Copper has a much better undertone, and is higher, as a result of the absorption of re-sale metal, and the feeling that the time is near for the large producers to announce a price which will interest consumers.

Zinc is extremely dull and lower, with betterment depending on the brass mills replenishing their supplies.

Tin is quiet at well maintained prices, but the outlook is not favorable for the dealers and brokers, because of the large available supply especially of Banca which is offered at concessions.

Antimony continues stagnant despite lower prices.

Aluminum is dull and unchanged at 58 to 60 cents.

The large orders which have been placed for 6 to 12-in. shells in the past 10 days will not help the metals to any great extent, inasmuch as they are of steel and do not require brass casings. Inquiry for the steel, amounting to several thousand tons, is before the trade. Export buying of steel products is heavier than at any time heretofore, and if it continues will adversely affect the domestic consumers who delay too long in covering future needs.

Pig-iron production in July was 3,226,719 tons or 104,088 tons per day, against 3,211,588 tons in June, or 107,053 tons per day, a falling off of 3900 tons daily. Weather conditions and repairs occasioned the falling-off.

Heavy lathes for shell making are in great demand.

COPPER

The market is stronger, not because there has been any buying of large proportions, but because the metal in second-hands is gradually disappearing; and more particularly because of a feeling that the time is drawing near when the leading producers will take action to stimulate business. Their quotations for months have been of a nominal character, and their attitude one of content in executing the huge contracts on their books. It is expected, almost any day now, they will fix a price at which business will go forward in fourth quarter and next-year deliveries. The better tone of the past few days caused prices to advance from 25 to 26.25c, for spot electrolytic. September electrolytic is around 25.50c, and November around 24.75c. Quotations have anything but a narrow range, and all that will steady the market is some indication of what price the big producers are willing to make. Lake is nominally quoted about 1c. higher than electrolytic. Copper for delivery in the first quarter of 1917 can be had around 24 to 24.50c. Meanwhile, near-by metal is rather scarce. The president of the Crocker-Wheeler Co., at Amper, N. J., S. S. Wheeler, manufacturer of electric motors, and a large consumer of copper, in commenting on the copper situation said: "I do not think that the present high price of copper will continue. But it will be a long time before it returns to its former level of 15c. How could it do so in the face of the unprecedented consumption that is still going on? Granted that production in America is greater than ever, most of this is under contract before it is shipped from the smelters, and there are practically no accumulations of metal to be found in middle-hands." He went on to say that many manufacturers had turned to substitutes for copper, but that they would return to its use when normal conditions are restored. The London market for spot electrolytic yesterday

was £125 against £122 a week ago. Exports in July totaled 35,018 tons, a satisfactory quantity.

ZINC

Another slump has hit zinc, and the market is dull and weak. Prompt and August were quoted yesterday at 9.25 to 9.50c, St. Louis, and 9.50 to 9.75c, New York, and it is probable that these figures might be shaded. September was about 9c, St. Louis, and last quarter about 8.50c. Brass-mill special is easily obtainable at 10.50 to 11c. The London market declined 25 yesterday, dropping from £60 which was the spot quotation a week ago. Not much change in the situation is looked for until the brass mills draw near the end of the contracts under which they are now being supplied with metal, and this may not be for a few weeks. Meanwhile, it would not be surprising if the metal dropped to a level in which some of the newer and smaller producers would find little profit. It is hinted that some of the strength of a week ago was due to a few interests which were short, and whose endeavors to get metal sent the market up and created a short-lived scarcity. Plenty is to be had today. Exports in July were large, amounting to 7979 tons. The new shell orders recently placed are all for the large sizes which do not require brass casings. Japanese spelter is becoming more of a factor in this market as well as abroad. Sheet zinc is unchanged at 15c.

LEAD

Fair activity has been shown in this metal in the past week, and these are indications that a movement of importance is not far away. The A. S. & R. Co. adheres to its quotations of 6.50c, New York, and 6.42 1/2c, St. Louis, and declares that it is taking business at these prices. The trade cannot understand the statement of the big company, in view of the fact that the smaller producers, all of whom have been taking orders, are quoting as low as 6.20c, on spot business, and down to 6.10c, for September. A notable feature in the past week is that the call has been principally for carloads of prompt shipment, an indication that consumers' reserve stocks are running low, and it is believed that should the leading interest drop to 6c, New York, heavy buying would ensue. Interspersed with the buying referred to were some fairly large export orders. The business done was handled almost entirely by the producers, dealers and second-hands doing little. The spot quotation at London yesterday was £28 7s. 6d. against £28 5s. a week ago. Exports in July totaled 2541 tons.

TIN

Business was fair on one or two days in the week, otherwise the market has been dull. The large stock available does not indicate strength for the near future. Deliveries into domestic consumption in July totaled 4172 tons, of which 832 tons came to the East via Pacific port. In stock at London on July 31 was 5928 tons. About on August 1 was 626 tons. The market, so far as the sellers are concerned, is adversely affected by the large quantity of Banca tin here and which, as usual is selling at substantial concessions from the price of Straits tin. Spot Straits was quoted yesterday at 78s. while Banca has sold at 37c.

ANTIMONY

This metal presents a similar picture. A few brands are down to 13c, duty paid, but still there is no demand. Some of the holders are said to possess stocks which they sold 30c per lb. The anxiety of the owners of such metal to dispose of their stocks, despite the fact that the market price is at a considerable loss, is likely to bear down the market even more than the lack of demand.

Recent Publications

COEUR D'ALENE MINING INFORMATION, 1916. Compiled by Wm. Wagner of Wallace, Idaho, between April 15 and June 15, 1916. P. 174. Index. May be obtained through the MINING AND SCIENTIFIC PRESS. Price, \$4.

The Coeur d'Alene mining district includes Shoshone county, Idaho, and the western part of Sanders and Mineral counties of Montana. It covers a considerable area, and contains many well-known lead-silver and zinc mines, as well as minor properties yielding copper, gold, and antimony; in fact, the Coeur d'Alene is one of the most important regions in the country. This little pocket-book has been carefully compiled and arranged. Alphabetically are given the names of 336 companies, their respective capital, officers, situation, and brief notes on the property. Several pages are devoted to production and profits; also something on the Wallace Exchange. We consider this a useful work, right up to date, although a map would have added to its value.

ORIGIN OF TEXAS RED BEDS. By Charles Lawrence Baker. Bulletin 29. P. S. University of Texas, Austin.

REGULATIONS COVERING COAL-LAND LEASES IN ALASKA. Approved May 18, 1916. Information regarding coal lands. P. 86. Maps. Department of the Interior, Washington, D. C., 1916.

U. S. Bureau of Mines, Washington, D. C., 1916:

GAS ANALYSIS AS AN AID IN FIGHTING MINE FIRES. By G. A. Burrell and Frank M. Sibert. Technical paper 13. P. 16. Illustrated.

QUANTITY OF GASOLINE NECESSARY TO PRODUCE EXPLOSIVE CONDITIONS IN SEWERS. By G. A. Burrell and H. T. Boyd. Technical paper 117. P. 17. Illustrated.

EFFECTS OF TEMPERATURE AND PRESSURE ON THE EXPLOSIBILITY OF METHANE-AIR MIXTURES. By G. A. Burrell and J. W. Robertson. Technical paper 121. P. 14. Illustrated.

COKE-OVEN ACCIDENTS IN THE UNITED STATES IN 1915. Compiled by Albert H. Fay. Technical paper 151. P. 17. Out of 31,960 employed 38 were killed, a decrease.

PRODUCTION OF EXPLOSIVES IN THE UNITED STATES IN 1915. With notes on coal-mine accidents due to explosives, and a list of permissible explosives, lamps, and motors tested. Compiled by Albert H. Fay. Technical paper 159. P. 24.

U. S. Geological Survey, Washington, D. C., 1916:

ASPHALT, RELATED BITUMENS, AND BITUMINOUS ROCK IN 1915. By John D. Northrop. P. 16. Chart.

GYPSUM IN 1915. By Ralph W. Stone. P. 9.

MANGANESE AND MANGANIFEROUS ORES IN 1915. By D. F. Hewitt. P. 15.

LODGE MINING IN THE QUARTZBURG AND GRIMES PASS PORPHYRY BELT, BOISE BASIN, IDAHO. By E. J. Jones, Jr. Bulletin 640-E. P. 29. Map.

POSSIBILITIES OF OIL AND GAS IN NORTH-CENTRAL MONTANA. By Eugene Stebbins. Bulletin 641-C. P. 42. Maps.

STRUCTURE OF THE VICKSBURG-JACKSON AREA, MISSISSIPPI. With special reference to oil and gas. By Oliver R. Hopkins. Bulletin 641-D. P. 28. Maps.

AN ANTECLINAL FOLD NEAR BILLINGS, NOBLE COUNTY, OKLAHOMA. By A. E. Fahl. Bulletin 641-E. P. 18. Map.

TRAVELOGUE IN CALIFORNIA, 1913-1915. Bulletin 641-C. P. 60. Ill. index.

THE LIGNITE FIELD OF NORTH-WESTERN SOUTH DAKOTA. By D. E. Winchester, C. J. Hargis, E. Russell Lloyd, and E. M. Parks. Bulletin 627. P. 169. Ill. maps, charts, index.

THE CHISANA-WHITE RIVER DISTRICT, ALASKA. By Stephen R. Capps. Bulletin 630. P. 130. Ill. maps, index.

Industrial Notes

Information supplied by the manufacturers:

In Price List No. 65 the CHAIN BELT Co., of Milwaukee, gives the cost of its 'Mogul'-steel bushed chain-belt, 'Durex' combination chain-belt, malleable iron elevator-buckets, and sprocket-wheels for detachable chain-belt.

The 'P. & H.' single-line grab-bucket of the PAWLING & HARNISCHFEGER Co., of Milwaukee is described in Bulletin 101. It is made of the best steel, with good mechanical details, and for handling sand and other fine material the machine has proved satisfactory.

The SULLIVAN MACHINERY Co., of Chicago and London, has established an agency in Holland with Messrs. Petrie & Co., Heerengracht, 141-145 Amsterdam, as its special representatives, who will sell the Sullivan products in the Netherlands. This new arrangement replaces the Sullivan agency previously at the Hague.

The INGERSOLL-RAND COMPANY has issued a catalog in Spanish under the title 'Productos de la Ingersoll-Rand.' This is attractively and well bound, and contains 124 pages replete with illustrations of descriptive matter and tabulated data. It should be of great service to Spanish speaking users of pneumatic machinery.

The third number of 'Roebeling Wire Rope,' the technical wire-rope bulletin of the JOHN A. ROEBELING'S SONS Co., Trenton, N. J., has been issued. It contains information on aerial wire-rope conveyors (continued), the right and wrong way to measure wire rope, the oldest suspension bridge in America, the Roebeling galvanized drop-forged wire-rope clip, wire-rope practice, incline planes, Roebeling wire-rope slings and ready reference tables. The information given is all of practical value.

The use of oxy-acetylene in cutting and welding metals is expanding rapidly, and like the pneumatic hammer it is difficult to see how engineers could get on without it. In Form W-308, the PREST-O-LITE Co., of Indianapolis has published a 45-page instruction book on this subject, written by H. Sidney Smith and A. F. Brennan. This fourth edition is sold for 50 cents, and will be found thoroughly practical. Details are given of the oxygen and acetylene apparatus, the blow-pipe, flame, preparation of materials, fluxes, actual welding, notes on the metals, and useful hints.

On account of change from steam to electricity, the steam power-plant of the Arkansas Valley plant of the American Smelting & Refining Co., at Leadville, has been purchased by the MORSE BROS. MACHINERY & SUPPLY Co., of Denver, and will be removed to its Denver warehouse for re-sale. The Lord Byron mill at Sagar Loaf, Colorado, is being dismantled by this firm and shipped to Denver. The Flint mill near Rollinsville, Colorado, erected two years ago, operating three weeks as a cyanide-plant has been purchased also. The Colorado & Eastern railway, a line running out of Denver to Seranton, Colorado, was recently purchased by the firm, which will dismantle and ship all the rails, locomotives, etc., to Denver for re-sale. The large plant at Leadville known as the Yak mill, situated near the portal of the Yak tunnel, was recently purchased. This was a 500-ton zinc-lead mill equipped with crushers, rolls, roasters, dryers, Cleveland-Knowles magnetic machines, tables, etc., all electrically driven. The original cost of the equipment was over \$200,000. The Geyser mine at Westcliffe, Colorado, equipped with the largest hoisting engine in the State and a complete boiler-plant, compressors, rails, cars, drills, pipe, etc., is being dismantled by the firm for shipment to Denver.

At the Buckeye Belmont mine, Tonopah, recent tests on the Dreadnaught drill were of considerable interest.

EDITORIAL

T. A. RICKARD, Editor

ANNOUNCEMENT of the resignation of Messrs. William B. Phillips, as President, and F. W. Traphagen, as Professor of Metallurgy, in the Colorado School of Mines draws attention again to the mishandling of this useful institution. When will the people of Colorado take steps to put the control of their School of Mines in good hands and take it out of petty politics?

POLITICAL discussion of the Mexican mess during the presidential campaign will have one good result: it will give our people an intelligent idea of the conditions in Mexico and of our responsibilities in the matter. Thus it should prepare the way for a consistent policy. The nomination of Mr. Franklin K. Lane on the Conference Commission has given keen satisfaction in the West.

MORE crude petroleum was marketed in the United States during 1915 than in any previous year, according to final figures just issued by the U. S. Geological Survey. The total was 281,104,104 barrels, valued at \$179,462,890. This is a 6% increase over the output in 1914. Prices were lower, however, the average for the country being 63.8 cents, against 80.6 cents per barrel in 1914. Only in Colorado and Wyoming did prices improve. At the present time quotations are rising steadily, and prospects of the industry are brighter. In 1915 California had to give way to Oklahoma for first place on the list of producing States.

METALLURGY nowadays wins more than one metal, sometimes three or four, out of an ore, so that it becomes difficult to decide under what category to classify a mine. For instance, in 1915 the group of copper mines in Shasta county, around Kennett, California, yielded 315,549 tons of ore from which was won

\$477,684 in gold	or \$1.51 per ton	
396,183 " silver	" 1.26 " "	*
3,772,218 " copper	" 11.96 " "	
1,022,722 " zinc	" 3.24 " "	

the total being \$5,668,897 or an average of \$17.97 per ton, as against a total of \$3,087,279 and an average of \$12.70 per ton in 1914.

IN a report recently written on a Californian mine we find the following: "In a rather hurried survey of your vast estate, taken from the back of a mountain pony, I saw many evidences that you have a valuable property, quartz croppings on hills and mountain tops, in gulches and canyons, and almost everywhere was seen the remains of extensive placer mining." This is

out of date, of course. Twenty or thirty years ago it was not so improper to inspect mines from the carriage deck of a mule or to appraise an ore deposit from the small end of a telescope, but the naivety of the gentleman is to be commended. He deceives nobody. His predecessors in the act of seeing mines where only holes exist were less scrupulous.

MINING men are returning to Mexico, despite the lack of protection from the Administration at Washington. Passports are refused by the State Department, yet the managers and owners of mines are going back because they know that this affords the only chance of protecting their property. On another page we publish the exchange of telegrams between a mining engineer and the State Department. We are informed that other engineers have had exactly the same experience, being told peremptorily that they must leave Mexico or stay at their own risk. It was the threat of war that made it dangerous to stay and not interference from the Mexicans, so say those operating on the West Coast more particularly.

SPELTER had a flutter during the last two weeks of July, rising from 9.25 to 10.50 cents, but soon receded to a new low point in the present market, namely, 8.25 cents. One smelter in Kansas is shutting down a block of furnaces, while others are not buying more ore than necessary. A mid-year statement on the metal has been issued by the U. S. Geological Survey, covering the first half of 1916. The supply totaled 330,922 tons, including 14,253 tons of stocks at the beginning of the year, 267,449 tons from domestic ore, and 48,756 tons from foreign ore, also 464 tons imported. There was withdrawn 20,197 tons for foreign export, 58,007 tons for domestic export, while stocks on June 30 were 21,000 tons. The apparent consumption was 228,700 tons. In addition to the retorts erected at the middle of the year, 193,696, there were 22,188 building or contemplated.

CONFUSION still exists among prospectors as to the basis on which ores of tungsten are bought and sold. It is possible to misunderstand, for instance, the meaning of "concentrate of 50% tungsten oxide" and to think erroneously that this means concentrate consisting of 50% scheelite or wolframite, which contains only about 60% of tungstic oxide, or tungstic acid. The confusion arises from the fact that tungstic oxide, which is the acid radical WO₃, cannot be visualized by a miner. He understands that a 10% zinc or copper concentrate means 10% of zinc or copper, rather than 10% of sphal-

erite or chalcocite, because he has seen zinc and copper in their metal forms. But he never has seen any tungstic oxide. A price of \$30 per unit of tungstic oxide means \$30 for each percentage, or 1% or 20 pounds. A price of \$30 per unit for 60% concentrate means \$1800 per ton for concentrate containing 60% tungstic oxide.

Stamp v. Ball-Mill

This case is on trial in the great assize of experience. We might have headed our article 'The passing of the stamp-mill,' but that heading has been used so often during the past twenty years and the stamp-mill has shown such stolid refusal to pass that it seemed wisest not to tempt the refutation of events so confidently. Any mechanical device that has withstood the whips and scorns of scientific observers for a time longer than the lives of most of its critics, and that still persists in holding its ground despite the onslaughts of competing inventions of greater ingenuity, must have sterling merit. Even its best friends, however, do not claim that as a crushing machine it is a model of efficiency, for the ratio between power consumed and work performed suggests a radical defect. The more frequent claim for the superiority of stamps is their simplicity both of construction and operation.

People are apt to regard the things they understand as simple, those they do not understand as complex. Is not this the real reason for the alleged simplicity of the stamp? Consider the innumerable adjustments that have to be made and the tendencies to a break-down. The foundation-bolt nuts must be tightened frequently; the screens watched with a vigilant eye; the chuck-blocks lowered and the false dies replaced as the shoes and dies wear down; the shoes and dies themselves must be replaced when worn out; broken stems have to be replaced and welded; tappets must be set so as to compensate for the wear of the crushing surfaces; the lining of the mortar is abraded; cam-shafts break, and so on. The 'fingers' that 'jack-up' the stamps have to be manipulated with careful skill; the clean-up inside the mortar is a time-wasting nuisance. The indictment becomes formidable.

Designers allow $2\frac{1}{2}$ horse-power for the operation of a stamp weighing 1000 pounds dropping 100 times per minute from a height of 6 inches, although the actual energy, as measured in foot-pounds, is equivalent to only 1.6 horse-power. What the efficiency is, based upon the power required for crushing ore in a theoretically perfect device, we do not know. Ordinarily, the capacity of a stamp such as is mentioned above may be taken at from 1 to 5 tons per day of 24 hours, with $1\frac{1}{2}$ -inch feed crushed to pass a 30-mesh screen, or not less than half a horse-power per ton of ore milled. The low output of the stamp is due in great part to its inability to discharge the crushed product when once reduced to the desired fineness. Various devices and improvements in design have been offered from time to time in order to overcome this defect. Multiple-discharge mortars of many

types have been invented, but, while they increase the capacity, it has been done at the expense of what is really the greatest point in favor of the stamp-mill, its service as an amalgamating machine. This, combined with the ability to effect a greater proportionate reduction in a single stage than any other device, plus the familiarity of the average mill-man with its many vagaries and complexities, constitutes the real reason for the hold it retains upon the affections of the miner.

It is not to be supposed that the stamp-mill has been able to retain its astonishing supremacy during all these years without a struggle. A bewildering array of competing apparatus has been introduced, good, bad, and indifferent. Every form of mechanical motion under the sun has been tried, from high-speed centrifugal machines that pulverize everything, including themselves, in no time at all, to some of the so-called pulverizers that gently massage the rock in a leisurely manner until it finally falls apart from sheer weariness. Some of the various roller-mills have found a comparatively limited field of application in the crushing of soft ores, or in performing their part in one stage out of a three or four-stage crushing operation. That is why the stamp more than held its own until the introduction of the cyanide process started a revolution in milling practice that shook the old battery to its very foundations.

It will be remembered that, in the development of cyanidation, leaching came first. Then, owing to the long contact required for taking the coarse gold into solution, fine-grinding was introduced, with its inevitable sequel, filtration, and with it the more or less complete rejection of amalgamation as one of the means of extracting the precious metal from the ore. When the need for a simple and effective fine-grinding apparatus was manifest, the engineer, casting about for something ready-made that would fill the bill, jumped over the fence into the field of cement machinery and lifted the tube-mill bodily into the domain of ore-dressing. It was soon discovered that the highly diluted pulps produced by the stamp did not give the best results in tube-milling, so pulp-thickening and de-watering devices were employed, until finally the classifier was introduced into the fine-grinding circuit, returning the oversize for re-grinding and sending the fine product to the cyanide annex for the extraction of its metallic contents. And still the old-fashioned battery thundered in the canyon, taking the product from the primary crushers at about 1-inch cube and delivering a 10- or 20-mesh product to the tube-mills. In a few instances, rolls and Chilean mills were substituted, but, generally speaking, our friend the stamp, after five hundred years of usefulness, continued to prove his marvellous adaptability by being ready to meet the latest of emergencies.

It would be interesting to know just what started the ball-mill epidemic. Here is another instance of borrowing the implements of the cement industry; in fact, as far as the crushing department is concerned, cement machinery has been annexed almost bodily by the metal miner. However, the ball-mill as a competitor of the

stamp is now an insistent fact, and it really begins to appear as if our old friend before long will have to join the innumerable caravan of the obsolete, retiring with horse-drawn vehicles and sedan chairs into the limbo of discarded things. There is nothing irrational about the popularity of the ball-mill. Speaking of simplicity, here is the real thing! Take a hollow shell; put a head at each end; provide means for rotating it at comparatively slow speed; punch a hole in one end for feed, and in the other end for the discharge; line it in such a way as to afford a readily removable shell on the inside; throw in a few tons of balls; and there you are; no hair-trigger adjustments, take-ups, or any other form of nuisance attending the operation of a stamp-battery. Each ball is a stamp that crushes and grinds; the rotary movement of the shell lifts the balls and drops them upon the pulp, which is actuated from the feed to the discharge by perfectly natural forces, and is gradually comminuted meanwhile. The coarse product will gravitate to the periphery, while the finer particles will work their way to the centre of gyration, in other words, the centre of the mill, and finally escape through the hollow trunnion at the discharge end. The pulp is agitated by the balls so as to be kept constantly stirred, breaking every particle. As for results, here are some typical figures made public by a well-known manufacturer of ball-mills. A mill in Canada had been operating eighty 1250-pound stamps and crushing 800 tons per day through 2-inch screens. The consumption of power per stamp, therefore, would appear to have been about 3 horse-power, or 0.3 hp. per ton of ore milled. By way of experiment, one ball-mill was installed, and, after four months' trial, it proved itself able to crush 498 tons per day, using 113.2 horse-power, with a charge of 28,000 pounds of balls, or 0.225 hp. per ton of ore milled. The floor-space occupied was about the same as would be required by ten stamps, or one-fifth that taken by the stamps per ton of ore milled. And there were no counter-shafts, pulleys, belts, tighteners, broken stems, cam-shafts or tappets to set up, or any of the other things that characterize the 'simplicity' of the stamp. That is also the opinion at Jumeau, where ball-mills are displacing stamps. The time has come to revise our opinions.

The Business of Mining

In a recent issue we published a commencement address delivered by Mr. J. R. Finlay before the Colorado School of Mines; on another page we reproduce the larger part of a similar address made by Mr. W. R. Ingalls before the Missouri School of Mines. These two engineers, besides giving nearly simultaneous lectures to our young men on a kindred subject, both served as secretary and president successively of the Mining and Metallurgical Society of America, an organization that has proved more influential than representative. Of course, the address by the editor of the *Engineering & Mining Journal* is as interesting to older men as it must have been to the particular

part of the audience for whom it was primarily prepared. Mr. Ingalls regrets the absence of regulations disciplining the mining profession. The Mining & Metallurgical Society introduced some semblance of regulation by restricting membership and it is conceivable that had it not been stranded on the shoal of exclusiveness it might have exercised a salutary influence on the profession. But the idea of forbidding a man to practice any profession is one unlikely to come into favor in this democratic country. The ideal of equality of opportunity is too precious to be endangered either by legislative restriction or oligarchic taboo. The definition of 'profession' as given in Webster's dictionary and quoted by Mr. Ingalls is not a good one, but it is good enough to introduce the suggestion of commercialism. Undoubtedly mining is a business, to which the profession ministers, and any mining engineer that expects to succeed must understand the various phases of this business to which his advisory functions are dedicated. Young men with high professional ideals may become disillusioned when they discover that the striking successes are won by financial shrewdness rather than by technical ability; but then comes the test of the true professional man: the love of his work, compensating him for the monetary gain that he sees escaping him. Doctors, lawyers, clergymen are recognized as members of professions because they treat their respective occupations as a vocation, although many of them might enrich themselves readily by selling automobiles, promoting mines, teaching the one-step, or dealing in real estate. So, we presume, there will continue to be simple-minded whole-hearted men willing to remain professional when they might so easily become predatory. However, it is good advice that Mr. Ingalls gives in urging misfits to change their employment. The square peg in a round hole is the type of misdirection. A good sales agent is the superior of a bad engineer. Those are fortunate that find the work for which they are adapted, and it is a splendid characteristic of American life that the change from one occupation to another is so easy and so reputable, affording men the opportunity to discover what they can do best, and giving them a chance to do it. Mr. Ingalls mentions four representatives of the 'generals' of mining. Let us add four representative 'staff-officers', E. P. Mathewson, E. H. Hamilton, Philip Argall, and Albert Burch. And to that we may append four representatives of the 'war council,' the men of proved sagacity in directing the broad lines of a campaign: H. C. Perkins, D. W. Brumton, D. M. Riordan, and E. T. McCarthy. These are merely typical; each reader can add to the number out of his knowledge and acquaintance. It is at least a sign of the times that the famous members of the profession, or business, are to be found in the class of 'generals.' They are men that were technicians until they became connected intimately with big enterprises and then, in some cases almost automatically, they participated in the buying and selling of mines, finally playing a hand in the big 'game,' as it is called in the West, of promotion and speculation. The stories of the late Mar. is Daly and

Mr. John D. Ryan are apropos, for the engineer must learn that the basic purpose of mining is to make money, not to dig holes or to spoil the scenery. We associate ourselves with Mr. Ingalls in his admiration for the work done by Mr. H. C. Hoover. He gave to the cause of Belgium what money could not buy—disinterested service and executive ability of the highest order. But we must demur to the Walsh story of the discovery of the Camp Bird. That story would furnish an excellent text for a commencement address if it were true. It is not. Mr. Ingalls mentions that the account as given by the late Thomas F. Walsh to an admiring class of students was re-printed in the journal of which he is now editor, but the true story was printed in the same journal before he became the editor of it. In 1899, three years after the event, and ten years before the official myth was propagated, Walsh told the present writer, in the presence of Andy Richardson, while all three stood close to the scene of discovery, how he had stumbled upon his fortune. His story, corroborated and corrected by his faithful retainer, Richardson, was recorded on the spot and the gist of it was published in the *Engineering & Mining Journal* of July 18, 1903. If that first published account had been incorrect it is probable that Walsh, or his manager John Benson, or other persons cognizant of the facts, would have corrected it at that time. It is not unusual for the finding of a rich mine to be credited wrongfully to scientific acumen. The simple facts become smothered in romantic details until a gorgeous myth passes current as history, to be retailed even by the discoverer himself, who finally persuades himself that it is true. In the same way W. S. Stratton was given credit for knowledge of chemistry and mineralogy, and, on the insistence of his friends, credited himself with them, although he had pottered around the one conspicuous outcrop in the Cripple Creek district for many days before at haphazard he chipped a piece of the decomposed granite, which proved to assay 19 ounces in gold per ton. Then the millwright graduated as a mineralogist, and in course of time he forgot, as also did his friends, that he had told the true story to a person able to record it. As to Walsh's story, "a slide of reddish pyritiferous porphyry" would be no "indication of gold" in a district where the andesitic mountains are red as radishes; nor does the Camp Bird ore carry tellurides "in circles of glistening black mineral." The thin dark bands consist of fine-grained galena and blende, the proportion of telluride being not only minute, but doubtful. Walsh heard about the 'telluride' long afterward, when Mr. F. L. Ransome had published his report on the Silverton quadrangle. The pink mineral that attracted Walsh's attention on the Gertrude dump was rhodonite; he mistook it for fluor-spar, with which he had become familiar at Cripple Creek and with which he associated the occurrence of gold.

What Mr. Ingalls has to say regarding the play of character in a technical career is well stated. So is the final insistence on the main purpose of both mining and metallurgy—to make money, not to apply geological

theories or to use pretty machinery; in short, as his whole address emphasizes admirably, the winning of the metals from the earth is not a scientific pursuit but a business.

Surficial Signs of Copper

The last of the series of articles on this subject appears in this issue, and we feel confident that our readers will feel under pleasant obligation to Mr. Frank H. Probert for his painstaking and illuminating analysis. The information he has given and the suggestions he has offered can, and will, be put to practical use by those in search of the metal that plays so important a part in civilization, and in the attempt to destroy it. The colors of the landscape, particularly in the South-West, will henceforth have a new meaning for the observant prospector, geologist, and engineer. Yellowness, rather than redness, will attract the eye of the seeker after another Miami or a second Chuquicamata. In his last article, the author, not content with his own observations, has been wise enough to gather the views of a number of engineers closely associated with successful copper explorations, adding thereby to the value of his own conclusions. Another phase of the subject, that of rock alteration, is reviewed, indicating the principal parts played by silicification and kaolinization. Here also Mr. Probert has drawn on the experience of other observers, submitting the opinions of mining geologists connected with important enterprises in Arizona and Mexico. His own successful diagnosis of the Ray deposit affords a striking example of the direct application of geology to mining and illustrates the economic value of these scientific studies. We hope that some of the gentlemen quoted by him will add further to the value of the essay by contributing comment and criticism. We are glad that Mr. Probert should conclude his present writing with a quotation from Mr. R. A. Penrose's paper on 'The Superficial Alteration of Ore Deposits,' for we believe that that particular article did a great deal to stimulate intelligent curiosity in regard to the nature of outcrops and proved of direct value to mining engineers in many parts of the world. That is what Mr. Probert, in turn, will have done. Such publication of individual observation and experience is a contribution to human progress that every man should aim to make, in return for the heritage of knowledge given to him gratuitously by others. We venture to close by referring to a pathetic incident. Among those lost on the *Lusitania* was C. T. Brodriek, a Harvard graduate and a young geologist of the greatest promise. He had been studying secondary enrichment and its allied problems in the Siberian copper mines and elsewhere, and on his last journey he carried with him a mass of invaluable manuscript recording his observations. This went down with the gallant ship when she was assassinated. If he had only had a multiple copy made, or if his notes had been printed, they would have been preserved as a fitting memorial to a truly scientific man and would have perpetuated the work to which he had applied himself so devotedly.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters relating to mining and metallurgy. The Editor will accept expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Americans in Mexico

The Editor:

Sir—The following telegram to the Department of State, and the reply, may be of interest.

TELEGRAM

San Francisco, July 30, 1916

Department of State, Washington, D. C.

I am an American citizen. July 8th left Manzanillo, Mexico, against my wish, after seeing telegram from Department saying 'Americans must leave.' Went to Mexico nine years ago after investigating and finding I had right to go there to live. All I have is in Mexico and remembering exodus of 1914 and the hardships caused have left my wife, mother and two small children at our home in Guadalajara, Mexico, with wife's father who is German. Wishing to return to my home please authorize passport and transportation or failing in this please authorize funds for bringing my family to this country and for our maintenance here and subsequent return to Guadalajara where we have the right to live and be protected as American citizens. There is no war with Mexico and having been advised to abandon the results of our work in Mexico by the State Department does not alter our rights nor the obligations of the United States towards its citizens. Awaiting favor of prompt reply so I may make plans accordingly.

R. S. BURDETTE,
Hotel Sutter.

ANSWER TO ABOVE TELEGRAM

Washington, D. C., Aug. 2, 1916, 2 pm.

R. S. BURDETTE, Hotel Sutter, San Francisco.

Your telegram July 31. Department does not deem it advisable for the present to withdraw the advice previously given American citizens to remove temporarily from Guadalajara district or to make exceptions thereto. Department will be glad to consider advisability issuing passport to you as soon as it is satisfied conditions in Guadalajara district warrant such action. You are in error when you state Department said in telegram Americans must leave Mexico. What it did was to advise Americans to leave Mexico temporarily for their safety. Department has no funds at its disposal that could be used for your maintenance in this country or for your return transportation to Guadalajara. You are further advised that only destitute American citizens in Mexico can be furnished transportation to their homes in United States.

FRANK L. POIK,
Acting Secretary of State.

Before I left Guadalajara, on July 3, the following telegram was received by the Americans remaining in Mexico:

Consular Department informed several hundred Americans in various parts of Mexico intend to disregard this government's advice to leave Mexico. This government feels that it cannot be responsible for any such Americans unless they

leave immediately. Unless they leave now the abilities to assist them in their exit will inevitably be rendered extremely difficult to accomplish. Impress on all Americans still in Mexico districts that they are assuming grave responsibilities if they should elect to disregard this advice.

(Signed) LANSING.

The telegram saying "Americans must leave immediately" I saw on board the *Maryland* at Manzanillo on July 8; for this the State Department denies responsibility in its answer to my telegram. This telegram was shown to me by U. S. Vice-Consul Stadden at Manzanillo on board the *Maryland* in the presence of the captain of that ship. I believe the telegram was signed by Admiral Fullan and both Stadden and the captain of the ship gave me to understand clearly that it came through the State Department and called my attention to the word "must" used in the telegram. I was anxious to go back on shore and return to my home in Guadalajara but decided to leave in view of the telegram and the urging of the Consul and captain.

Comparing my telegram and the reply received one can easily see how discouraging it is to be an American citizen in Mexico. In general, those of us who have lived in Mexico consider our Government's policy grossly inefficient. Through incompetence or stupidity it is causing the ruin of over 90% of the people of Mexico both financially and morally. The richer classes have in large measure moved to other countries, the middle-class has for a long time been living without hope and pawning their little valuables; the poor class has been forced to trade their women and daughters for a bare existence. Hunger makes many men do things that are ordinarily condemned by well-fed human beings.

I do not speak disparagingly of the Mexican people. The conditions thrust on that country, largely by the action of the United States, have made it impossible for many millions to gain a livelihood, and I doubt if the behavior of any other race would be better if placed in the same helpless position through circumstances beyond their control.

It is easy for some one to suggest that the Mexicans should free themselves from these conditions. The problem is a large one, but Mexico would probably have come to a solution before now if our special representatives had been competent and the information they gathered had been acted upon, instead of trying to make the case fit the impossible policy of our administration during the past four years at the cost of thousands of innocent lives while our State Department talks of "humanity."

and dodges all of its real obligations to Mexico as a nation and to its own citizens in and out of Mexico, as well as to foreigners who must be protected if the Monroe doctrine is to hold.

R. S. BURDETTE.

San Francisco, August 4.

The Burden of Mailed Advertising

The Editor:

Sir—With ever increasing volume the desk of the mine manager is burdened with advertising matter that comes through the mail in the form of letters until it has become a nuisance and a pest. Mining men are proverbially up-to-date in their business affairs and constantly on the look-out for improvements in machinery and methods; but this does not mean that busy men give their time cheerfully and patiently to running through a mass of letters addressed to them only to discover that none of it has any particular value for them. They would not give half an hour a day to a book-agent or a peddler; why be expected to give it to a solicitor that gets into the office surreptitiously through the mails? Mining men look to the columns of their professional and trade journals for information as to advancement in the line of mining and ore-treatment; and they look to the advertising columns of these papers for information concerning machinery and supplies that are safe to buy. Some of the largest advertisers in the trade papers are the most persistent solicitors through the mails, but I cannot believe it pays. In an experience of more than twenty years I do not recall buying any sort of an article because my attention has been called to it by a mailed circular. Invariably I consult the columns of the Press or other paper. Somehow that seems to be the legitimate method of soliciting trade. It is open and above-board, and in the long run must be able to stand competition and investigation. Not so the mailed circular, which can make any sort of claims regardless of actual facts. Editors even of high-class journals do not of course guarantee the statements of their advertisers, but they do not long tolerate advertising by unreliable concerns; and thus the appearance of an advertisement in a journal like the Press carries with it a certain air of respectability and worth. The concern publishing it at least keeps good company. The mailed solicitor, on the other hand, comes along like a thief in the night, and even if he is thoroughly honest he bears no signs of a good character. But the worst of him from the busy man's standpoint is his impertinence and his waste of valuable time. He comes in without knocking, plants his feet on your table, and there remains until you can find time to discover whether he has a legitimate right to your time or is an imposter. By law all advertising matter appearing in publications must be specifically marked as such either by form or by label; the law should provide that all soliciting sent through the mails should be plainly labeled 'advertising matter' on the wrapper. The busy

manager could then consign it to the waste basket without loss of time and patience.

R. N. FLETCHER.

Reno, Nevada, August 1.

[We sympathise with our correspondent. The only corrective to the nuisance is a large waste-paper basket, like our own.—EDITOR.]

Cyaniding Flotation Concentrate

The Editor:

Sir—In your issue of June 24, M. G. F. Söhnlein disagrees with sundry points in my article appearing in the issue of April 8, 1916.

Mr. Söhnlein is quite right in what he has to say regarding classifiers and the Frenier pump when used with ordinary mill-pulp. My description of these machines applies only to the treatment of clean sulphide minerals, which is quite another matter.

The Frenier spiral pump can best be applied for low lifts up to 10 ft. in the case of clean sulphides of high specific gravity. However, I prefer a well-designed centrifugal pump (of the Byron-Jackson type), for elevating the sulphide-pulp overflow (200-mesh material) from a Dorr combined hydraulic and rake classifier to the thickeners or agitators. I am certain this arrangement will give the minimum of trouble. The most recent plants for treating concentrate are using the centrifugal.

Belt-bucket elevators have not met with much favor at cyanide-mills treating concentrate. However well designed they may be, it must be admitted that they cause as much trouble as any machine about the mill. Long elevators give more trouble than the short ones. Such has been my experience.

Mr. Söhnlein agrees that "when a pulp is so fine as to pass 100-mesh, pumps are also satisfactory and cheaper to install." Such is the case with a cyanide-mill treating concentrate (clean sulphide from tables, vanners, or flotation) where all the pulp (product to be elevated) overflowing the Dorr classifier will practically pass a 200-mesh screen. What he has to say about the combined hydraulic and mechanical classifier applies only to the usual mill-pulp containing minerals of widely varying specific gravity. His statements do not strictly hold for the classification of a more homogeneous material (clean sulphide) concentrate, at which my article was aimed. The figure of 30 to 35% moisture in the coarse concentrate is too high. This is my mistake. There is every reason to expect a less moisture when the discharged coarse material contains less undersize.

A. E. DRUCKER.

London, July 25.

[Evidently Mr. Drucker's experience with elevators has not been satisfactory, yet in many plants they work well at low cost. In our issue of February 15, 1913, we described an elevator at Goldfield.—EDITOR.]

Synthetic Nitric Acid

By F. H. Mason

The daily papers, from time to time, have been impressing on capitalists the desirability of erecting a plant for the manufacture of nitrates in the United States, and one enthusiastic booster, in a San Francisco daily, pointed out that a nitrate plant and a health resort should be established at the same place, because the former would help the latter by removing nitrogen from the air, and thus leave a more invigorating atmosphere for the invalids. It is not necessary to say here that in the synthetic preparation of nitric acid from the atmosphere more than twice as much oxygen as nitrogen is removed, but the enthusiast need not be afraid that such a plant would injure the Californian climate, for even if a plant were started it would have no more effect on the composition of the atmosphere than the salt-plants on the shores of San Francisco and San Diego harbors have on the salinity of the Pacific ocean.

The American business man is not slow to grasp opportunities, nor does he, as a rule, require to be urged by the daily press; the latter more often trails along in his wake, inaccurately reporting his aims and ambitions and the progress he is making in the industries to which he has turned his attention. We may be assured, then, that there is some good reason why capitalists of the United States have not taken up the manufacture of nitrates from the air. Certainly the reason is not lack of raw material, for it has been calculated that above each square mile of the earth's surface there is some 20,000,000 tons of nitrogen and 5,000,000 tons of oxygen; enough raw material, in all conscience, without taking into consideration the law of diffusion of gases. We know, also, that extensive water-powers are available in both the United States and Canada to supply the necessary energy. We must look, then, for some other cause, and in doing this it will be well to see what has been done in Europe, where plants for the synthetic preparation of nitrates have been in operation for several years.

The preparation of nitric acid from the atmosphere is no new discovery. When Cavendish, in the 'eighties of the 18th century, was making his historic experiments on the composition of water, he noticed that when hydrogen and air were exploded in a eudiometer* the resulting water was invariably acid, but when hydrogen and oxygen were exploded the resulting water was neutral. From this he rightly concluded that the nitrogen, as well as the oxygen and hydrogen, had taken part—though only to a small extent—in the chemical reaction, and, in 1784, he demonstrated this by preparing nitrate of potash by passing electric sparks through equal volumes of oxygen and nitrogen in a globe contain-

ing a small quantity of a solution of caustic potash. It was found to be necessary to remove the nitric peroxide as soon as made—as with caustic potash, for instance—or that already made would be decomposed into its original elements by continued action of the electric discharge, and it is this that has been the stumbling-block that has held back the commercializing of Cavendish's discovery for a century and a quarter. The simple equation $N + O = NO$ is reversible, and unless the nitric oxide made is immediately removed from the conditions that brought about the combination of its elements the reverse equation takes place.

With increased facilities, however, Birkland and Eyde, in 1903, were able to prepare nitric acid from the air on a commercial scale, and four years later they erected a plant at Notodden, in Norway, utilizing a water-power of 40,000 hp.; and other works, using other kinds of furnaces, quickly followed.

The furnaces employed for the manufacture of nitric acid from the air vary considerably, but the object of all of them is to bring the air into intimate contact with an electric arc, for, it is generally conceded, electricity, as well as intense heat, plays an important part in uniting the two gases. In the Birkland-Eyde furnace, the electrodes are two copper pipes, cooled by water, through which a high-tension alternating current of 5000 volts passes; poles of a powerful electro-magnet are placed at right angles to the electrodes at the point where they approach each other, and flare the arc into a disc; this is enclosed in refractory material, and air is blown through the disc-like arc, where it is raised to a temperature of from 3000 to 8000 °C. The gases issuing from the furnace are cooled as rapidly as possible to 500 °, because it has been found that while temperatures above 3000 ° are best suited for the formation of nitric oxide the range between 2500 ° and 1000 ° is favorable to its decomposition. The gases are passed under boilers, where they are used to generate steam, into the oxidizing-chamber, kept at 50 °, where nitric oxide is converted into nitrogen peroxide by surplus oxygen. From the oxidizing-chamber, the gases are passed to a series of absorption-towers, where they pass up through broken quartz and meet a descending shower of water or acid, which converts the nitrogen peroxide into nitric and nitrous acid:



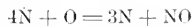
It would appear from the equations that such nitrous acid is formed, but in practice this becomes unstable with increasing concentration, and splits up thus:



*A graduated glass vessel used in volumetric analysis.
EDITOR.

the NO is oxidized to NO₂ as it passes through the towers. The weak acid obtained from the last tower is pumped into the one preceding it, then into the next one, and in this way the tower nearest to the furnace is made to produce an acid of 40 to 60% strength that it used to decompose limestone, forming nitrate of lime, which, after evaporation, is ready for the market.

If the combustion of the air were complete in accordance with the equation



—too much to ask, of course—the gases issuing from the furnace should contain 40% nitric oxide, instead of which if they contain 2.5% of that gas the furnace is considered to be doing unusually good work. The weak point, then, about the process is the inefficiency of the furnaces. The issuing gases from the Birkland-Eyde furnace contain 2% of nitric oxide, many furnaces produce less, few more. One reason for this low efficiency is that the atmosphere contains four parts of nitrogen to one of oxygen while the proportion required for the reaction is equal parts of each gas, so that 60% of the gases passing through the furnace serves no useful purpose, while it absorbs an immense amount of heat. It has been found experimentally that by adding oxygen in the proper proportion to form nitric oxide to the gases entering the furnace as much as 14% of nitric oxide was contained in the gases issuing from the furnace, but this, of course, is impracticable commercially on account of the cost of oxygen.

Here, then, in the inefficiency of the process, seems to be the reason that the American business man has not turned his attention to the manufacture of nitrates. There are innumerable uses for electric power that will bring an infinitely better return, and, now that power can be transmitted economically long distances from where it is generated into electricity the man who develops the power usually looks for a better return on his investment.

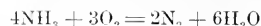
There is, however, an indirect method of preparing nitric acid from atmospheric nitrogen that gives greater promise, and seems likely entirely to supersede the direct combustion of the atmosphere. This, like the other, represents the commercializing of knowledge that has been the common property of chemists for a number of years. Soon after the discovery of ammonia it was found that its combustion with oxygen produced nitric acid and water, and as long ago as 1830 Kuhlmann produced nitric acid by the oxidation of ammonia by aid of a catalyst. But in these days ammonia was far too costly for the process to be economically successful. Recently, ammonia has been prepared by a number of different ways, directly and indirectly, from atmospheric nitrogen; it is made by direct union of its elements, the nitrogen being separated from the oxygen of the atmosphere either by fractional liquefaction or by passage over heated copper. By the latter way, an almost oxygen-free nitrogen can be obtained, while the copper oxide formed can be rehabilitated by passing coal, water, or natural gas over the heated oxide. The nitrogen and hydrogen are made to

unite by the aid of a catalyst—generally uranium is used—at 500 to 700° C., and the best results are obtained under a pressure of 3000 lb. A simpler process for making ammonia is that of passing superheated steam over cyanamide, the last having previously been made by passing nitrogen through calcium carbide heated to 800°. Another method of preparing ammonia is that of first preparing nitride of alumina by heating bauxite and carbon in an atmosphere of nitrogen in an electric furnace. The nitride is treated with caustic soda when the following reaction takes place:

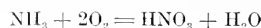


By neutralizing the sodium aluminate with acid a pure alumina, that can either be marketed or used for the production of more nitride, is obtained. Calcium and magnesium nitrides also have been used.

The ammonia, by whatever method obtained, is mixed with ten times its volume of air and passed rapidly over a catalyst consisting of platinum, the face of which is covered with platinum black. The preparation of the catalyst is all-important, as if an excess of plating black is present there is a tendency to get the reaction:



instead of the desired one:



The mixed gases are passed through porcelain-lined or enameled-iron tubes into a chamber containing the catalyst where the oxygen and ammonia unite; the resulting nitric acid, water, and nitrogen are led through a series of towers packed with broken quartz or earthenware where the nitric acid is condensed by a stream of acid falling through the earthenware.

When nitric acid is made by the oxidation of ammonia it is usually neutralized with ammonia, forming ammonium nitrate, which as a fertilizer contains 35% of nitrogen, as opposed to 16.5% in sodium nitrate, and which is used extensively in the manufacture of some explosives.

It will be seen, then, that the indirect method has the great advantage that, beside being more economical of power, the site of the plant is not confined to the neighborhood of a huge water-power.

IMPORTS OF CRUDE AND SCRAP ALUMINUM in the 11 months ended May 31, 1916 were only 7,551,063 lb., against 11,978,283 lb. and 14,868,574 lb. for the same periods in 1915 and 1914, respectively. In 1915 imports were 8,534,834 lb., compared with 23,185,775 lb. in 1913. On the other hand, exports have increased. For the 11 months ended May 31, 1916, they were valued at \$5,156,342, against \$2,994,476 and \$1,040,686 in 1915 and 1914, respectively. Decreased imports are a supporting factor of the market, now 58 to 60 cents, and new uses of aluminum continue to be found.

THE URYANHAI PROVINCE of Siberia is considered to be of considerable promise by some English mining men who were investigating the area last year. Asbestos, coal, copper, and platinum deposits have been found, as well as gold.

Surficial Indications of Copper - V

By Frank M. Probert

In the four preceding articles I have attempted to review, in sequence, the factors that influence the outcrop and tend toward the concentration of copper salts to form ore. It is not necessary to summarize the ideas already expressed, although I would again emphasize the fact that metal mines are found in connection with igneous rocks, that these are present in mountainous districts, that conditions favoring fairly rapid circulation increase the possibilities of oxidation and enrichment, and that the erosion of the surface causes a lowering of permanent water-level. These features should be studied, and inferences drawn from topographic and climatic conditions.

In appraising the value of prospective mineral land, there is seldom anything but the bare surface of the ground and the engineer's experience to guide him. It has been said that "analogy is a dangerous weapon in the hands of the inexperienced."¹ It is, but the Latin idiom *"experientia docet"* may be freely translated "experience does it." Examining a new district, with little or no underground development, we must interpret the surface signs by the light of experience. The key to the door of a mine may be found in the outcrop.

The color scheme of the earth's surface defies the palette of an artist; how much more so must it baffle the description of a mining engineer! Still the color or discoloration of rocks is important. I have said that any unusual surface feature warrants investigation. Striking colors, particularly the reds and deep purplish-browns, beckon the prospector. The presence of copper is often denoted by the color of iron oxides, this on account of the universal association of the two metals, the predominance of iron, and the strength of the red as a permanent pigment. The surface coloring of vein outcrops is generally more striking than that of the disseminated deposits because of the greater concentration of metallic salts per unit of area, and again, because most of the 'porphyry coppers' have suffered long continued erosion and they are only commercial because the chalcocite zone is comparatively near the surface.

The color of outcrops will vary with the nature of the enclosing wall rock. Veins in limestone are more highly colored than those in quartzite or the igneous rocks. Limestone often shows a spread enrichment at the surface, the iron waters replacing the wall-rock for considerable distances beyond the actual limits of the fracture. Hematite coloring is common in the lime sediments, whereas the quartzites may be superficially painted with copper silicates without much iron.

The yellowish-brown color of contact metamorphic

areas is quite characteristic with occasional blotches of copper paint. The outcrops generally weather in bold relief.

The amount of surface coloring increases in the desert areas, partly on account of the more rapid oxidation, and partly because of the high evaporative factor. Then, too, arid sections are seldom forested, so that the coloring of mineral deposits is more conspicuous. Little or no difficulty will be found in recognizing the outcrop of veins, but the disseminated deposits must be more carefully studied. As a little oil will spread out over a large surface of water, so a little copper will stain a large land surface. It is often deceiving. I am no longer attracted by a chain of blood-red hills; they suggest to me the presence of lean pyritic mineralization without enrichment. Red Mountain, near the Three R mine, at Patagonia, Arizona, is brilliantly colored by iron oxide. It can be seen for many miles. On going over the surface of this andesitic porphyry mass, dirty yellowish patches show melanterite stains, and a few inches below the surface the unaltered barren pyrite is found, peppered through the slightly altered rock. Oxidation is shallow but the surface discoloration is vivid. At the Piedras Verdes, a name wholly unsuitable, the same condition exists, although here, as I have already mentioned, there are local segregations of oxidized copper ore.

La Caridad, near Nacozari, presents a most brilliantly painted landscape. The country is extremely rugged, suggesting periodic but torrential rainfall. High on one resistant peak a small orebody of enargite, which, by the way, is extremely persistent even in the presence of strong oxidizing waters, was mined. The rest of the mountain chain is barren. I use this word in a commercial sense. In looking for disseminated copper ores, avoid the intense flush and seek the more neutral tints of creamy-yellow or buff-grey.

The 'porphyry coppers' owe their commercial value to the continued and advanced oxidation and concentration of the copper contents of large masses of low grade sulphides. Chalcocite is the resulting product, scattered throughout a highly altered rock-mass. Chalcocite does not contain iron, hence its oxidation leaves no red stain behind. Such staining as does occur is due to the oxidation of imperfectly replaced pyrite, and the more highly colored the surface of these deposits, the greater the possibility of early impoverishment. At Morenci, Metcalf, Santa Rita, in parts of the Inspiration and Ray districts, and at Bingham, the porphyry or monite is of a creamy yellow color, bleached at the top. It, of course, shows unmistakable evidence of great rock alteration. Local patches of green coloration indicate the greater thickness of the orebody, and incomplete oxidation of the

¹T. A. Rickard. Lectures on Economic Geology, University of California, February, 1916.

protruding knobs of chalcocite. As Ransome says, "the largest orebodies of Miami are not often found under those surface rocks that are most vividly colored by copper compounds or iron oxides."

At Ray and Miami, the ore is found in a sericitized schist. The surface is of a pale chocolate-brown color, in which the pearly sheen of the sericite plates is seen plainly. Frequently a film of copper silicate paints the cleaved surfaces. I would here point out that at Morenci and Bingham such surface evidence of copper as is presented is in the form of carbonates, both the hydrous and anhydrous, whereas, in the silicified sericitized schist, silicate paint predominates. There is marked kaolinization of the monzonitic porphyries, marked sericitization of the schists.

To confirm opinions formed from many years' study of copper deposits, I wrote to a number of engineers asking for an expression of their views. One of our leading copper specialists thus replies: "It is said that if you know a subject you should be able to speak and write about it. I fear, however, that when it comes to describing the characteristics of the outcrop of a so-called disseminated property, I will have to fail." Such a frank statement emphasizes the necessity for systematic study of this subject. I take this opportunity of inviting a liberal discussion of my tentatively expressed ideas. Constructive criticism is more helpful than casual comment.

J. Parke Channing writes me: "The outcrop at Miami was a massive rock, intensely silicified, stained red in patches by iron oxide, and showing only occasionally small green stains of copper. The marked thing about it, however, was the fact that the rock undoubtedly had been intensely altered and while the presence of a small amount of copper was interesting as showing that copper had been one of the primary constituents of the rock, still the fact that there was not very much copper indicated that most of it had been leached and presumably precipitated. The No. 1, or Captain shaft, showed very much more copper on the surface than did the No. 2, or Red Rock shaft, and, as it turned out, the best ore was under the Red Rock shaft. The No. 3, or Red Spring shaft, was sunk in an area where there was a great deal more iron; in fact, the rock was soft and contained large quantities of iron oxide. It turned out that the zone of enrichment there was not over 8 or 10 ft. thick, and I imagine that the primary rock consisted largely of pyrite containing a little copper."

Walter H. Wood says of Miami: "The schistose area of the Miami Copper Company is netted with contraction fractures and later fissuring due to metamorphic changes of volume, accompanying mineralization and alteration. The ore belt is marked by silicification and intense alteration of the schist, a change that fades out into natural gray schist a few hundred yards north of the Miami and Inspiration mines. The ore zone is oxidized and leached to an average depth of 210 ft., this part containing small seams and veinlets of oxidized ore. Below this leached belt a few feet of mixed ore is succeeded by the zone of disseminated glance, a rather soft, much altered rock speckled with tiny glance grains and films."²

Pope Yeatman describes the mineralized surface of the Chile Copper Co.'s property as being gentle hillslopes, in a rainless district, of equable climate the year round, but where dews are heavy. He attributes the crusts that form on the surface to the action of the dew in furnishing moisture for dissolving the soluble salts. The orebody lies in an intensely crushed area of granodiorite. The actual surface is leached, is of a dull-gray color, and much fractured. The ore is the brochantite of the oxidized zone, due to the oxidation of chalcocite. A fresh face in the shovel-pits is green, due to the presence of this mineral. Some sections are iron-stained, but here pyrite is more plentiful. The transition zone between the brochantite and chalcocite is quite wide, hence this deposit differs from those of the disseminated sulphide ores in the United States.³

In summing up an article on "Disseminated Replacement Copper Deposits," C. W. Botsford writes,⁴ "The necessary phenomena attendant on the formation of a disseminated copper-ore deposit of the replacement type are:

1. An intrusion of granitic to monzonitic rock of some size, carrying a considerable percentage of iron minerals.
2. After solidification a general fracturing, while still at high temperatures. This may affect neighboring rocks, which may subsequently be mineralized.
3. The mineralization of large volumes of rock by euphriferous pyrite with the necessary accompanying metamorphism resulting in a quartz-sericite rock with few remains of the iron minerals.
4. Uplift of mass and exposure to atmospheric conditions.
5. Large areas showing residues from leaching.
6. Arid to semi-arid conditions and a rather mature topography where the rate of erosion must be slower than the rate of oxidation.

With these conditions fulfilled, the existence of a disseminated orebody is probable."

J. M. Buntwell describes the mineralized monzonite mass at Bingham as follows:⁵ "The occurrence of disseminated copper ore in igneous rock in Bingham shows that this extensive mass of monzonite carries disseminated throughout its areal extent, so far as known, irregular grains of pyrite and chalcopyrite; that the known mineralized tract is characterized, not by a series or succession of normal fissures, but by multitudes of thin, unsystematized parting-planes; that the rock is exceedingly altered by bleaching and silicification, especially in and adjacent to zonal areas of strong shattering; that assays show copper to be lowest at the surface and in old workings; that in relatively firm unaltered rock the copper ore lies in flat scales and films on the silicified walls of cracks, while in areas of great shattering and alteration, it occurs abundantly both on quartz-coated cracks and disseminated in the silicified bleached walls. In brief, copper is disseminated at depth through-

²"Copper Handbook," Vol. XI.

³*E. & M. J.*, Feb. 12, 1916.

⁴*E. & M. J.*, Vol. 95, p. 622.

⁵*U. S. G. S.*, Prof. Paper No. 38.

out the porphyry and occurs most abundantly in areas of maximum crushing, silicification, and alteration. Such general features as this apparently indicate a relation between quality of ore and degree of opening, alteration, and silicification, and suggest that the metallic contents reached their present state through secondary agencies."

In the tenth annual report of the Utah Copper Com-



HEMATITE VEININGS IN ALASKITE. COLOSSUS VEIN, 3 R MINE, PALM ONIA, ARIZONA.

pany, D. C. Jackling states that the ore-area now proved is 226.3 acres, with an average thickness of 455 ft. There is 380,000,000 tons of ore developed, of which 270,000,000 tons is classed as fully exposed. The year's addition (1914) was 10,000,000 tons in excess of that mined. The average assay of fully developed ore is 1.57%. In calculating this average grade, 56,714 samples, representing 334,518 linear feet of development, were taken.

Rock alteration is another helpful factor in sizing up the possibilities of a district. Advanced alteration, decomposition, and disintegration are reflected in the topography and areas of gentle slopes, or rounded hills are more promising for large low-grade deposits than rugged country. Such a surface is also easier to mine by the modern methods devised for the extraction of large daily tonnage.

P. B. Scotland, mine manager for the Arizona Copper Co., writes me: "The productive copper veins of the Morenci-Metalf district mostly occur in the more silicious phase of the porphyry intrusion, and their outcrops are characterized by heavy copper staining, frequently constituting ore. They are generally fault-fissures of varying magnitude and show very prominent outcrops of fault-breccia. The Coronado vein is the most important deposit of this type in the district. Its outcrop shows highly silicified iron-stained fault-breccia with occasional patches of partly oxidized sulphide ore showing. As a rule there is from 200 to 300 ft. of leached vein-matter before the sulphide zone is reached.

The outcrops of oxidized ore are therefore very common that have resisted weathering.

"The outcrops of broad metal-bearing intrusions in this district generally show iron stained open spaces in the matrix and in the joint planes of the porphyry. The degree of iron-staining is not great; it is more favorable to find the iron-staining extensive in area rather than intense in degree. Heavy iron staining may indicate the surface oxidation of a very pyritic deposit or vein with only a shallow and unimportant zone of enrichment beneath. A brecciated and faulted condition of the quartz-porphyry is favorable. A quiescent state of cooling of the magma, indicated by decided joint planes is unfavorable. Surface copper stains if confined to the more silicious and resistant parts of the outcrop are promising indications but in outcrops in more basic porphyry, staining may be entirely absent. Fragments of quartzite and limestone, floated in the porphyry magma, will generally show strong metamorphism.

"Veinlets of secondary quartz are common in copper bearing intrusions, but not necessarily indicative of orebodies beneath.

"The ferro-magnesian or dark minerals are invariably bleached and destroyed in any porphyry intrusion in which mineralization and enrichment has occurred and the feldspar is always changed to sericite or kaolin. The porphyry has always a characteristic crisp and weathered texture that is indescribable. In any particular



HEMATITE OUTCROP, OLD DOMINION MINE, ARIZONA.

porphyry intrusion, the most favorable ore is found where doming of the superimposed sediments has occurred. In other words, porphyry sills are so far ore bearing. I have observed rocks at the base of porphyry stock showed all the favorable outcrops of ore while sills branching therefrom show a more magnesian or dark some (is quite uncertain)."

The outcrop may be enriched not only by increment of metal but by abstraction of other material. Limonite and secondary silica will remain, outlining the casts of eroded sulphides, and these cellular outcrops often contain the precious metals. The completeness of the process of leaching depends on the relative solubility of the rock-constituents and the presence of effective precipitants, which may arrest the migration and cause residual masses of oxidized ore.

Of the many phases of hydro-metamorphism that influence the outcrop, kaolinization is, I think, one of the most important. Kaolinization must not be confused with sericitization, the processes are totally dissimilar. Kaolin is formed by the action of sulphate waters on the alkaline feldspars and their products, whereas sericite denotes hydro-thermal metasomatic reactions. Kaolin may be, and often is, an after-product of sericite. If the rocks, generally acid intrusives, are abundantly kaolinized, it indicates the complete oxidation of original sulphides and suggests enrichment below. Kaolinization is accompanied by a decrease of volume, with increased porosity. It tends to destroy the original structure of the rocks; hence, if on close examination the outlines of the feldspars are sharp, it is reasonably certain that the alteration is superficial.

A letter received from W. H. Emmons says, in part: "The silicification and kaolinization, other than the presence of copper salts, should lead us to the discovery of the porphyry deposits. My detailed work on this subject was done at Cananea. There a distinct segregation of silica was noticeable above some of the altered ore-bearing porphyry."

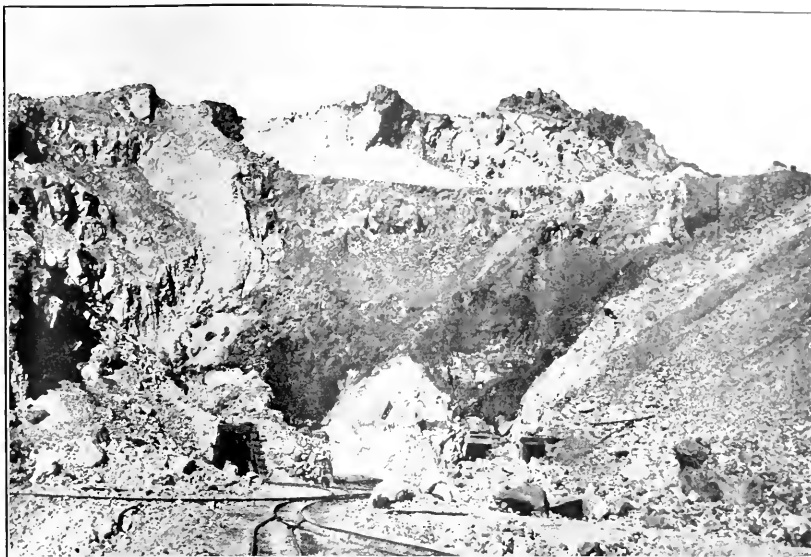
Silicification of the surface is significant, particularly as found in shear-zones or brecciated areas. Arthur Notman, geologist to the Copper Queen Consolidated, writes me from Bisbee concerning the newly developed porphyry mine on Sacramento hill: "The mineralization of Sacramento hill is confined to certain well-defined areas of brecciation, which have their greatest development at the east and west ends and south of the main axis of the hill, toward the contact with the Paleozoic limestones. The mineralization, consisting of pyrite, chalcopyrite, and bornite, with secondary chalcopyrite and covellite and associated silica, has replaced both the cementing material, largely silica, and the fragments. The proportion of sulphides in the ore so far developed is rather high, as indicated by the fact that experimental concentration shows a ratio of only about four to one. The copper content is materially higher than in most disseminated ores. The large tonnage already developed, including all material above 1.6% copper, shows an average of about 3.5%. In the west end of the hill particularly, the change from the breccia ore to contact deposits in the limestone is very gradual. The boundary of the mineralized zone of the north, away from the limestone contact in the case of the west-end orebody, is marked by a very strong fracture-zone, of apparently pre-mineral origin. At the east end, there are no such clearly marked structures. At surface, these brecciated areas have been altered almost entirely to hematite, limonite,

and silica. Copper-staining is conspicuous by its absence, there being only one or two places that show any traces of the carbonates or silicate. This is true also of the leached zone below surface, which contains practically no oxidized copper, save here and there for a few feet above the zone of secondary sulphides. The depth of the leached zone varies from a minimum of 100 ft. to a maximum of 200 ft., with an average of about 160. Toward the bottom of the leached zone, kaolin and other aluminous compounds appear in rapidly increasing amounts, and continue through the enriched zone, gradually giving way to sericite and unaltered feldspars as the zone of primary mineralization is approached. In all cases, there is a leached zone above the enriched zone."

A silicified outcrop is a favorable sign when the silica is of a crypto-crystalline variety, formed either by magmatic waters, by the carbonatization of feldspar, or by the abstraction of alumina from kaolin. Such silica is frequently found with sulphide ores or in the oxidized zone near the surface. Silicious outcrops often give place to a softer leached zone a short distance below the surface, as at Cananea.

In my first report on the Ray Central mine, I said in part: "The mineralized portion of the Ray field is not characterized by marked topographic detail; the hills present a rolling surface with but few cragged outcrops. Particularly is this the case where diabase comes to the surface, which, on weathering, crumbles to a soft rich brown earth so that it forms gentle slopes and saddles in the landscape. The ore deposit is in a locally crushed quartz-mica-schist, highly altered and silicified. The schist is foliated and cut into angular fragments by an interlacing network of tiny quartz films and veinlets, and by joints stained by films of iron oxide and copper silicate. As a rule, the rock breaks into fragments, the planes of which are not those of foliation."

J. E. Spurr, in his exhaustive geological report on the property of the Ray Consolidated Copper Co., discussed in great detail all the factors that have determined the present orebody. He says: "The Ray orebody belongs to a class of disseminated deposits in schist and porphyry. It has been silicified by the primary mineralization, hence the exposed part west of the Ray fault, being relatively resistant, stands out as a ridge of hills. It is iron-stained from the alteration of the original pyrite. The area of the maximum primary mineralization generally corresponds with that of maximum secondary ore-formation. The main belt of primary mineralization was thoroughly shattered during the fault movements that succeeded the original ore deposition. It contained only a fraction of a per cent of copper, so was not commercially valuable. From it the present orebody, averaging 2 to 3% copper, has been concentrated by downward percolating surface-water, which permeated the shattered rock, oxidized the superficial portions, dissolved out the copper and carried it down to the ground-water level, where it was precipitated as the rich copper sulphide, chalcocite. The primary orebody was first exposed to surface-waters by early Tertiary erosion. Subsequently it was covered up by the various desert wash



OPEN-CUT, SHANNON COPPER CO.'S MINE, METCALF, ARIZONA. (OXIDIZED ORE IN CONTACT METAMORPHIC LIMESTONE.)



CAVING SURFACE OF DISSEMINATED 'PORPHYRY COPPER' DEPOSIT, RAY CON. CO. IN CO., RAY, ARIZONA

and volcanic deposits of the Tertiary, and during this period of burial there was probably no secondary concentration. With the removal of the Tertiary covering, the ore-belt was again exposed to the surface, and climatic conditions appear to have been favorable for secondary concentration throughout most of the Pleistocene."

"Certain conditions have affected the process of secondary concentration. The surface of the secondary ore follows in a general way the larger inclinations of the surface. In detail, however, the apexes of certain sharp ridges are marked by corresponding troughs in the ore. This is believed to be the result of scant rainfall and defective underground circulation. Certain relatively impervious rock-formations have operated to retard the downward passage of surface-waters, so concentrating and localizing the secondary ore-deposition. In the Ray, Parson, and neighboring claims, a relatively thin sheet of diabase has been an important factor of this sort. Where this diabase is fortuitously so placed that it coincides with the ground-water level, it has been very effective in diminishing the thickness and raising the grade of the secondary ore-zone.

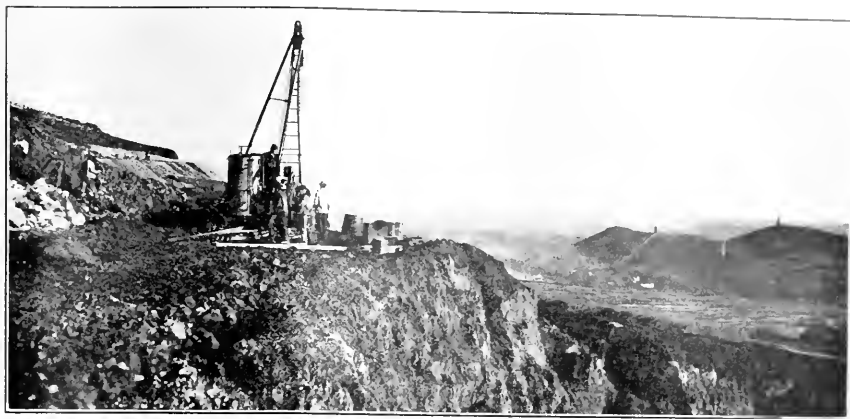
"Porphyry dikes, especially when kaolinized, and fault-zones where marked by soft gouge, also constitute relatively impervious layers that have locally deflected the circulation, and affected the localization of secondary ore. The diabase was, at the time of the primary mineralization, highly pyritized, but very little silicified. The alteration that took place tended to make it a soft tough rock not easily permeable to ground-water, hence it commonly contains, even quite close to the surface, a little slightly altered pyrite, while the adjacent granite-porphyry has been entirely oxidized and the copper leached out. These sheets and dikes of diabase frequently check the downward flow of water and concentrate the circulation along their upper margins. Chemically, the diabase appears to have been an unusually active precipitant of secondary as well as primary ore, apparently distinctly more so than either the schist or the granite porphyry. This is probably on account of the large amount of iron contained in the diabase, which is believed to have precipitated the copper from solution. Along the upper contacts of the diabase, therefore, the grade of the ore tends to be unusually high; while beneath, it is often unusually low.

"Strong copper staining at the surface is considered an unfavorable indication and is a symptom that the downward migration of the secondary copper zone has not been able to keep pace with the down-cutting erosion, so that part of the copper in the rocks is being carried away by the surface drainage while another part tends to scatter, seeking lower levels. Throughout the productive area, there are very few copper signs on the surface to indicate the remarkable chalcocite zone beneath."

While discussing the Ray district, it will not be out of place to describe the oxidized indications of an orebody that has no surface expression. The Globe Isabella group of the Ray Central Company, at the time of my examination in 1909, had been systematically drilled by

churn-drills and fairly well developed by underground workings, and, as a result, the bond on the property was relinquished. When I was called in by the old Ray Central company, I made a careful geological survey of the property and prepared glass models so that I could visualize the trend of the diabase sills and the effect of the rock-structure. A churn-drill chart gave the record of a hole that passed through leached schist for nearly 400 ft., and entered, without warning, clean chalcocite ore running 5 or 6% copper, which slowly faded off into leaner material. It was a perfectly good hole with no caving, and no casing was required. The record was blue-penciled "Assays unreliable." From my geologic study and the models, I was convinced that there was a depressed area or basin in this section that offered possibilities of great local concentration that had been penetrated by this drill-hole. I carefully examined the workings on the 400-ft. level and noted in the white silicified schist appreciable quantities of native copper and cuprite. From the sections, I saw that the orebody dipped about 20° to the east, following a diabase sill, and about the same angle to the south. I knew of the Mineral Creek fault to the east and its possible effect. On the 300-ft. level, a drift 400 ft. north of the co-ordinate on which the drill-hole had been sunk, showed a plentiful development of chalcotrichite in a highly sericitized and silicified schist. The general trend of the orebody suggested that this development was in the oxidized shell and, assuming that it maintained its dip, it would pass below the 400-ft. level and correspond with the results obtained in the drill-hole. From these data I outlined the approximate shape and extent of the orebody; as was verified by a small amount of development work. When the property was absorbed by the Ray Consolidated, the engineers estimated the net value of this orebody, allowing for amortization and all contingencies, as being approximately 44 million dollars. It was the salvation of the Ray Central.

I have made excerpts from the extremely interesting paper of Ira B. Jarolemon descriptive of the Ajo district, Arizona. "The mineralized area of about 55 acres, proved to depths of 400 to 600 ft., is a coarse quartz-monzonite originally overlain by a rhyolite cap, subsequently removed by erosion. The mineral is primary chalcopyrite and bornite, with little or no chalcocite. The monzonite is thoroughly shattered and silicified, at times entirely replaced by secondary silica. Pyrite is conspicuously absent. Very thin films of chalcocite are sometimes found immediately below the water-level, which, in this case, has no relation to the surface contours, although the bottom of the belt of oxidation parallels the water-plane. The variations in the grade of ore are due to the intensity of the primary mineralization and not to the enriching after-effects of solution and precipitation. The surface alteration is entirely unlike other low-grade copper districts. The sulphide bodies are capped by a crushed silicified material stained with malachite, limonite, hematite, and a little chrysocolla. The rock is hard, although the feldspars are partly kaolinized, which are in places stained green by absorption of copper from descending waters. The hills are of



EAST END OF THE RIO TINTO WORKINGS.



SACRAMENTO HILL, BISBEE, ARIZONA, AN ORE-CLEARING PORPHYRY MASS - 1901 PHOTO BY U.S.G.P.

(After Ransome, U. S. G. S. Prof. 1907)

a deep red-brown color with splashes of copper paint in protected places. The oxidized zone is constant in value from top to bottom, and in actual copper-content assays the same as the sulphide ore below. Malachite forms 85% of the oxidized mineral. Here, then, is proof that there has been little or no migration of metal or descent of surface-waters much below the exposed surface.

"To the east of this proved orebody, the same monzonite is soft and kaolinized, yellow in color, due to limonite, with but slight copper staining. The section is low and rolling, contrasting strikingly with the bold brown and green outcrops of the silicified ore-zone. The mineralization is pyritic, of low copper tenor, and the outcrop has more limonite and alumina and less silica and copper than the commercial deposit. There is a narrow belt of enriched chalcocite ore below. The ground-water level is constant throughout the district. Post-mineral erosion has been more rapid than oxidation. In the oxidation of the silicious chalcopyritic orebody very little free acid was formed to kaolinize the feldspars. The waters were evidently carbonated and the copper solutions early arrested in their descent. This is largely due to the aridity of the district."

I may add that there are 12 million tons of oxidized ore averaging 1.54%, and 28 million tons of sulphide ore running 1.5% developed in this property.

At the Old Reliable mine near Copper Creek, Arizona, the outcrops are essentially blow-outs or chimneys of rough, craggy, light-colored rock rising several feet above the weathered surface of diorite. The ore is primary chalcopyrite in a gangue of quartz and sericite with accessory tourmaline. Cavities or vugs in the brecciated material are lined with stout quartz crystals. The orebodies are of the pneumatolytic type.

The mines of the Moctezuma Copper Co., at Naco, Arizona, show mixed limonitic and hematitic croppings cementing a friction-breccia of andesitic rock, which weather out as two bold pillars, hence the name Dos Pilares. The outcrops contain carbonates of copper, but not in profitable quantity. The ore below has not been greatly enriched by secondary processes.

At Cananea, in Sonora, Mexico, a district I have not visited for seven or eight years, I remember well noting the great difference in the appearance of the outcrops of the contact metamorphic limestone deposits and the mineralized porphyry areas. The former had conspicuous gossan outcrops, with much silicate of copper, while the latter were leached and indicated the enriched chalcocite below by the rusty surface and general silicification. I should point out that in nearly all the areas in which copper is mined from contact metamorphic deposits, by far the larger part of the total output comes from the enriched ore concentrated in the intrusive porphyritic rock. This is well worth noting. The garnetized areas will resist erosion and attract attention, they will also furnish desirable oxidized ore for the smelter, and they may be included in the indicators of enriched porphyry deposits.

F. L. Ransome ascribes the lack of enrichment at Yerrington, in Nevada, to the impenetrability of the

rock-mass, and to the fact that erosion has kept pace with oxidation.

The Chilean mines owe most of their prosperity to rich secondary ores developed in regions of low rainfall and slow erosion. In the desert areas, oxidation may reach a depth of 1000 ft. locally, and rich masses of chalcocite and oxidized ore are frequent. At Cerro de Pasco, which is situated on the Andean plateau of Peru, 14,000 ft. above sea-level, the oxidized zone, to a depth of 300 ft., carried exceedingly rich silver ore. Famatina, in the Argentine, is in a mountainous and dry region, where erosion is slow and the water-table deep. The gossan has been leached of copper, but carried gold and silver. A zone of oxidized copper ore succeeds, carrying up to 15% copper, with 66 oz. silver, and 1 oz. gold per ton, while most of the primary sulphide ore carries only 4% copper.

At the Three R mine, at Patagonia, Arizona, the country is rugged and there is little opportunity for much of the rain-water to seep into the rock mass, except in the major faults. One such fault, the Colossus, showed considerable fracturing of the alaskite on either side of the main break. Hematitic staining was the sole indicator of the remunerative orebody subsequently mined below. The friable hematite outcrop gave place suddenly to lenses of pure glance. Stopes were mined 20 ft. wide of solid glance in an aluminized alaskite gangue, in an orebody 300 ft. long and 400 ft. deep. The lenses were connected by highly altered rock in which blebs of glance were irregularly distributed. There were a number of parallel faults, but the Colossus was the only one that showed this shattered outcrop and incidentally was the only one that was ore-bearing.

J. E. Carne says of the copper deposits of New South Wales, Australia: "The surface staining is very delusive. The most favorable indications are cellular iron oxide and secondary quartz, but this is only presumptive evidence, and not an infallible guide." The Barra and Moonta, of South Australia, had nothing at surface to suggest the carbonates and chlorides that were mined at a depth of 180 ft. except a concentration of lead minerals and precious metals.

The outcrops of the Great Cobar lode, in New South Wales, form a low ridge in a monotonous level country of Silurian sandstone and slate. Mineralizing agencies have hardened the lode; the sandstone is silicified, and the slate ferruginous. Copper showed only in one place on the surface. At 150 ft. the ore is a mixture of carbonates and chalcocite, while the oxidized zone extends to 250 ft., below which primary sulphides, pyrrhotite and chalcopyrite, are mined.

In Shasta county, California, some of the orebodies do not come to the surface, others have comparatively small outcrops, others have outcrops disproportionately large compared with the small orebodies underneath. The exposed portions of the orebodies have been much altered producing a gossan of limonite, some magnetite, and other ferruginous oxides. Iron has been oxidized and rendered stable to atmospheric conditions. Some of the dissolved copper has escaped into the surrounding country-rock, but most has been concentrated below as

chalcocite, bornite, and chalcopyrite, which, on further reduction, has formed native copper, cuprite, and to some extent, the carbonates. Silver was similarly concentrated. The partly impregnated wall-rock has been sericitized and kaolinized, stained red by iron salts. This has led to confusion and misconception regarding the connection of outcrops with the larger orebodies. The orebodies are of deep-seated origin and have only been exposed by long continued erosion. The present topography is widely different from that at the time the ores were formed. The topographic conditions are no criteria as to the depth of ore.

I have already described the attractive outcrops of similar enriched pyritic masses at Rio Tinto.⁶

Descriptions of outcrops could be multiplied indefinitely until the copper mines of the world were exhausted. Every district, in fact, every mine, has peculiarities all its own; there are no two alike; even so, the more extensive our field of observation and the greater the number of deposits with which we are familiar, the better prepared we shall be to pass judgment. Our ability to observe correctly must be fundamentally sound and we must discriminate between that which is apparent and that which is inferential. Similar conditions will bring about similar results, but we must be sure that conditions are similar, or our anticipated results may never materialize.

In this series of articles I have endeavored to point out the sign-posts to be read in the examination of a copper prospect. In the light of our present knowledge of the subject, it is impossible to make positive statements. In conclusion I suggest that an engineer always look for signs of widespread mineralization. If the metallic vapors have been strong enough to form important orebodies, they will have effected rock-alteration over a large area. There may be but one local concentration, but iron-stained surfaces, pyritic mineralization, veinlets of ore, kaolinization, and other indicators will be found all around. Copper deposits are generous with their outcrops and invariably in districts of productive mines there is ample mineralized territory. The possible size of the orebodies can be determined by an accurate decipherment of the general, aerial, and structural geology, and the grade of ore will be indicated by the rock-alteration, color of outcrop, the climatic conditions, and extent of erosion.

Oxidation tends to obscure the primary mineral relationships and causes a segregation of newly formed minerals. The order of attack by oxidizing influences varies directly as the relative affinities of the several metals for oxygen and inversely as their affinity for sulphur.

It is important to find out the nature of the primary ore. Old workings or deep canyons may show this, and if lean sulphides appear near the surface, no matter how gorgeously colored the outcrop, it is well to consider seriously before recommending the expenditure of money. The nature and extent of leaching, if correctly

diagnosed, other factors being satisfied, will often decide for or against development.

Ransome, in his able paper presented to the Canadian Mining Institute in March, 1910, reviewed the criteria of downward sulphide enrichment.⁷ Summarizing his views, confirmed by my own observations in the field, it would seem that progressive impoverishment of similar sulphide deposits, as depth is attained, in any given district is indicative of secondary enrichment. The change in the zonal arrangement should show dependence upon recent topography. The presence of such minerals as chalcocite or covellite is almost indisputable evidence that the primary ores have been oxidized and concentrated.

The presence of kaolin or alunite at any horizon in a copper deposit must be secondary and is due to attack of sulphate waters on gangue-material. Alunite is quite extensively developed in the so-called porphyry coppers. The pseudomorphous replacement of one mineral by another is, *per se*, evidence of change, as is also the encrusting or veining of one mineral by another.

"Just as a pearl in the oyster is an abnormal segregation resulting in a beautiful gem, so the ore-shoot in the earth is an abnormal segregation resulting in precious metals; just as there are thousands of oysters that contain no pearls to one that does, so there are apparently thousands of favorable receptacles for ore-shoots that yet carry none; just as the pearl diver finds it remunerative to hunt for the oyster that may contain his prize, so the miner finds it remunerative to hunt for the spot that may contain his ore-shoot; and though the paths of both are strewn with disappointed hopes, yet, the possibility of realization leads them on."⁸

QUEBEC province, Canada, produced in 1915 increased amounts of asbestos, chromite, magnesite, and copper-pyrite. The output of asbestos was 114,115 tons of picked fibre, worth \$3,544,392, an average of about \$30 per ton for the various grades. This is an increase over the \$2,895,935 produced in 1914, a consequence of the greater amount shipped to the United States, which is manufacturing asbestos articles for South American and domestic consumption that were supplied formerly by Germany. The output of chromite in 1915 was 14,976 tons worth \$221,287, a value of \$15.70 per ton. More than half of this, 8473 tons, was shipped to the United States. For several years the production of chromite and magnesite in Quebec had been practically nil. The magnesite produced in 1915 was 16,285 tons worth \$137,304, a value of \$8.50 per ton. The output of copper-pyrite ore in 1915 was 112,769 tons worth \$1,029,605, or slightly over \$7 per ton. Much of this came from the Weedon mine north of Sherbrooke, and was shipped by rail to smelters in the United States for treatment. Asbestos from Arizona is competing with that from Quebec and in 1915 the Arizona product brought an average price of \$41 per ton.

⁶Economic Geology, Vol. 5.

⁸R. A. F. Pentecost, Jr., Economic Geology, Vol. 1, p. 3.

The Business of Mining

By W. R. Ingalls

*I have called the subject of my address to you, 'The Business of Mining.' Here is my first exhibition of heresy. Some may think that in addressing a class of embryo mining engineers, I ought to talk about the 'profession of mining.' But no, that does not sound just right. I should say rather the profession of 'mining engineers.' We mining engineers are strongly given to talking about our profession, about its dignity, about its ethics, and so forth.

Now, during recent years I have been wondering more and more whether we are not rather highfalutin' in talking about ourselves as professional men, and if we are not really simply business men and are shutting our eyes to the fact. Of course, this idea does not apply to the mining and metallurgical engineer alone. It pertains to the civil engineer in general, using the term 'civil engineer' in contra-distinction to military engineer, which was its original meaning, long before it became substantially restricted to the railway-builders, bridge-builders, and their kindred. As between the civil engineer, in this broad sense, and the physician, surgeon, lawyer, and clergyman, there is surely a difference. The medical, legal, and theological men all have to comply with certain regulations, either prescribed or sanctioned by the State. If they misbehave, they are liable to lose their right to practice. There is neither such a requirement nor such a penalty in the case of the engineer. He practices of his own free will and he may misbehave grievously without losing the right to practice, although he may lose the esteem of his fellow-men. Furthermore, the medical, legal, and theological men have a certain standing in the eyes of the law. If they are the holders of professional confidences, they are supposed not only to preserve them, but also may not be required on the witness stand to disclose them. The engineer also is under this moral obligation, but he possesses no such legal inviolability. In this respect the journalist probably has more of a legally recognized character than the engineer.

Well, what is a professional man? What is a profession? Let us refer to Webster's dictionary:

"PROFESSION. That of which one professes knowledge; the occupation, if not purely commercial, mechanical, agricultural, or the like, to which one devotes one's self; a calling in which one professes to have acquired some special knowledge used by way either of instructing, guiding, or advising others or of serving them in some art; calling; vocation; employment; as, the profession of chemist. The three professions, or learned professions,

is a name often used for the professions of theology, law and medicine."

This is a definition that illuminates rather than defines. The engineer when engaged in a mechanical operation, and that is the largest part of his work, is inferentially excluded, but when he employs the special knowledge that he professes to have acquired either for instructing, guiding, or advising others, he may be considered a professional man. I might also do some quibbling with respect to the doctors and lawyers, some of whom are charged distinctly with practices of commercialism, and are criticized for not conforming to the principles of altruism that are supposed to govern professional practitioners. Well, let us engineers brush away all pretences. Let us admit that in the main we are engaged in mechanical occupations, the prime purpose of which is to produce. The engineer constructs things and operates them when constructed. He is engaged in a business and needs no code of ethics beyond those that prevail in all kinds of commercial life as a guide of correct conduct. The young man who leaves school and enters into life with any other idea than this is likely to do himself harm.

How often have we seen graduates of mining-schools lingering unsuccessfully in a vocation for which they were unfitted, sustained by a pride in what they call their profession, reluctant to confess that they had made a mistake in going into something for which they were not adapted. I recall a young man of this sort who was graduated from a distinguished mining school and promptly called himself a mining engineer. He was not an engineer then, nor at any subsequent time—he had not the kind of a mind that an engineer must have—but he stuck on, flitting from one petty job to another. I urged him to switch to something else, but my suggestions were not favorably viewed. On one occasion, however, he got so far as to inquire of me what I should advise him to take up.

"Well, Brown," I said, "you will probably be shocked. I feel certain that you were not cut out for an engineer. But I have a notion that you would be a first-rate salesman in some business associated with engineering."

Of course he went right up in the air. The possessor of an engineering sheepskin to be a salesman! Perish the thought! He left me to take the superintendency of a pecayune mine, having a good title, but a dubious stipend. In a few months he was out of a job again and trying to collect arrears of pay for his last one. Then for several years I saw nothing of him. I surmise that he just managed to exist on fitful occupations. But mind you, he was during all this time a mining engineer and a professional man.

*Annual Commencement Address, School of Mines, University of Missouri, May 26, 1916.

One day he was ushered into my office and greeted me effusively. He was arrayed with elegance and exhibited many evidences of prosperity. He informed me early in our conversation that he had quit engineering and had become a salesman; that he had lately closed a half-million dollar contract and was going to be the general sales-agent of his company. He was not even sheepish in his confession; also he had forgotten my own advice to him.

I knew another young man who threw up a good but subordinate position for which he was well fitted to go into the field as advisory engineer. I urged him not to do it, pointing out that he was unfitted for it, and also that the unattached engineer is likely to experience six lean years to every fat one; but unfortunately, he had a fat one, right in sight. After a while the lean ones came and things began to be harder and harder. He used to send me desperate appeals for help and advice. Finally he wrote me that he was quite unable to earn a living by his profession; that he was just managing to get along by selling soap; what should I advise him to do? I replied that if he had found he could not get a living by what he called his profession, but could get it by selling soap, the logic of the situation seemed to me to point to his continuing to sell soap. However, in the course of time, he fell into a more congenial but modest niche in engineering and then was well content to stay there.

My purpose in relating these anecdotes has been to point out to you young men that you should not be led astray by pride in a supposed profession, which really is not a profession so much as it is a business avocation; and, secondly, that you should not hesitate to abandon your now chosen work if you find later that you are unfitted for it and made a mistake in choosing it. We all make mistakes and shall continue to do so as long as we are human. The most that any of us can hope for is not to make the same mistake twice, but, alas! we do even that. It is no confession of incapacity for a young man to say five years after graduation that he made a mistake in studying mining; that he would better have been a farmer or a merchant. It would, however, be distinctly a confession of incapacity to stick to something to which you know yourself to be unfitted, or something that is uncongenial to you.

Now, I am not the materialist that perhaps my words have indicated. On the contrary I am an idealist. All my life I have been doing those things that I liked to do and have not thought enough about what they paid. We have several kinds of engineers. There is first of all the great body of men who operate our mines and metallurgical works. They are the subalterns, captains, and colonels of our army. Fewer in number are those who advise about the development of mines, build metallurgical works, devise new metallurgical processes. They are the staff-officers. Many of them are great scientists, whose work is often inadequately required. Finally there are the engineers in whom the business instinct is highly developed—men like Jackling, Hoover, Hammond, Bradley—who are our generals. I admire the engineers of each of these classes. Each in his own way, humble or

high, is doing necessary work and contributing to the wealth that the mining industry bestows upon the world.

However, in mining, as in everything else, the scarcity is in good officers, and the higher you go, the greater is the scarcity. Every man in the ranks, every one of you, like Napoleon's soldiers, carries a marshal's baton in his knapsack, meaning that the road of promotion is perfectly open. Whether you will travel that road rapidly or not depends upon yourself alone. Now, please note that among our engineering generals the predominant characteristic is their business instinct. Their engineering training has been relegated to the background. There have been and are many generals who have had no engineering training, or have acquired it incidentally, without going to school for it. Such a one was Marcus Daly, a very great general, and among the many stories of him I recall one that illustrates my idea. It is reported of him that he used to say:

"I listen to the reports of my engineers and then I lock myself in my room lest they influence my judgment."

This did not mean that he depreciated either his engineers or their advice, but simply that he had to consider other phases of the question than those of purely engineering character.

And similarly, John D. Ryan, another great general, lately said to me:

"If the Anaconda company should do all the good things its engineers recommended, it would never pay a dividend. They are good engineers, and most of the projects they urge are good, but if we carried out all of them our capital would be perpetually tied up."

Here we have one of the great functions of the business general, namely to control expenditures within the limits of what can be afforded, having in mind first of all the interests of the stockholders, the owners of the business.

I am disposed to think that it is exactly this sense of perspective that the technically trained engineer must seek, especially to obtain, if he hopes to rise high in rank and material success. We have all noticed cases where the engineer upon assuming the duties incident to general management, considered many of his new duties as less important, and more or less subordinate to those of engineering, and would still dwell upon the engineering functions of the business instead of developing the possibilities in his new and broader field of effort. The technically trained man too often overlooks the fact that a knowledge of the markets where the materials and supplies necessary to production may be secured; their purchase, transportation, and storage; the employment and application of labor, supplies, and power; the supervision, compensation, and organization of labor, and the proper balancing of the activities of each department to itself and its relations to the other departments, the adjusting of the business as a whole to the activities of the outside world; the proper planning and analyzing of the operations of the business, the knowledge of the markets in which the production must be sold, together with the

selling of the production; the raising of working capital, disbursements and investment of earnings; are all functions of the business of mining that are separate and distinct from that of engineering and are co-ordinate in importance. And finally, there is ever to be borne in mind the great key of the secret of success in business administration, namely the getting of other people to do things for you, whether they be people that are working for you, people with whom you come in contact as buyers and sellers, or people who can in any way assist you in getting things done. The man who possesses this art is often described as a 'good mixer.' Uncouth and imperfect as that term may be, it expresses nevertheless something of the quality that is important.

In the development and equipment stage of mining and metallurgy, good engineering is all important. With a badly developed mind and a poorly designed metallurgical plant, the best of administrators is bound to have a hard time. It was formerly the custom, in the days when our industry had not attained the organization of the present era, that the mining and metallurgical engineer was a jack of all trades. The same man might develop and equip the mine, design and build the smelting plant, and operate both of them. That day is long past. Not only do we now specialize between mining and metallurgical engineers, but also do we specialize among builders and operators. One kind of metallurgical engineer designs and builds the plant and turns it over to the other kind to operate. In the two branches of work, a different kind of talent is necessary.

But of course the operating men are the great majority of the technically trained engineers engaged in the mining industry. Among them there is no question that we need a greater increase in business efficiency, a greater direction of attention to mining as a business, rather than as an art and science. The great need among our great mining and metallurgical corporations, which have wonderful technical departments and magnificent mechanical equipment, is not so much for more technical and mechanical efficiency, as it is for more business efficiency, more intelligent purchasing, better organization, better recognition of the principles of economics. The genius who possesses those qualities shines the same in whatever he undertakes. The mining industry does not merely obtain its generals sometimes from other fields. Often it gives its own men to other work. Consider Hoover, a mining engineer relatively young in years, who has become one of the great figures of the world. We of the mining industry knew Hoover as a great administrator long before the world at large had heard of him. During the last two years we have seen him, who had been conducting brilliantly mining operations in all parts of the world, exercise the same talents in feeding and clothing a nation.

The story of how the Belgian Commission, under Hoover, supported a people requiring \$65,000,000 per annum in food supplies with but \$10,000,000 in foreign contributions, is one of the romances of business. The British press has consistently asserted that it is not the

generosity of Americans for which Belgium should be most grateful, but for the commission's organizing genius, which is to say Hoover's genius. The problem was huge. It was necessary to utilize the credit of a population deprived of all metallic and almost all paper currency; to do a systematic banking business across enemy lines. Hoover's commission had so to organize its charity that the destitute in Belgium should be aided by their own countrymen. Its direct efficiency is attested by the fact that by careful purchases, the chartering of ships, and the substitution of volunteer effort for middle-men it kept the price of bread in Belgium below that in London and yet made \$6,000,000 profit on its sales during the first year. This was business.

I have dwelled upon some of the matters that you have not learned about in your course in this excellent school. Nobody learns about them in any school. I aim to impress upon you that in leaving your Alma Mater, where you have gone through some hard training under the guidance of able teachers, you have nevertheless been doing nothing but preparatory work. You must realize that your education and training have just begun and if you are to develop in your chosen work, you must keep on studying as you have been doing, but if anything, harder. You are no longer going to come up for examinations at the end of semesters, at which you are striving for marks, but you are going to be examined just the same, by the men who are employing you and their examinations will be the real thing. They will test what you know and that will mean dollars and cents, reputation and even livelihood to you.

How then are you to fit yourself for these coming examinations? I cannot suggest to you any simple *vade mecum*, no pony, crib, or dope-book; not even any plain line of conduct, practice, or study. As well as I can generalize, the broad precept is self-cultivation. Pay attention to everything that you are doing, whether it be work or play. Perhaps the best rule I can give you is: Observe and think. I venture to say that it is precisely that rule that your teachers in this college have been trying to impress upon you. Without any doubt, they have aimed especially to train you to think about the problems in mining and metallurgy that you are going to run into. Probably they have also trained you somewhat in observation, but alas, the training of most of us in observation is defective. We have not the excuse of the blind man afflicted by nature. We possess the sense of vision; but we go around with our eyes open and see not. Sometimes we do not even see enough to take care of our persons, and allow ourselves to be run down by automobiles. One of the most exasperating things in our business is the difficulty of getting young men who will see. In the mine, in the mill, in the smeltery, they will overlook the clues to the riddles, simply for not having been trained adequately to observe and report.

Listen to the story of how Thomas F. Walsh laid the foundation for his great fortune. This was told by Mr. Walsh in an address to the graduating class of the Colorado School of Mines upon an occasion similar to this,

and was re-printed in the *Engineering and Mining Journal* under the sub-caption of "Use Your Own Eyes and Judgment." That is merely a different way of putting what I have already said to you, namely, "Observe and Think."

Along in the '80s, millions of dollars were expended in the development of silver-lead veins and the erection of mills in the Imogene basin, nine miles from Ouray, in the San Juan region of Colorado. The mines proved disappointing. In the course of time the mills and machinery were dismantled and sold. In 1896 when Walsh visited the region, it had been condemned as a failure and exhibited all the aspects of a "busted community."

The country was abandoned, save by one Andy Richardson, the original prospector. One day Walsh went with Richardson to examine a claim near the summit of the range. The trail ran along the slope, and high up the side of a steep mountain. About three-fourths of the way up Mr. Walsh noticed a slide of reddish pyritiferous porphyry, which attracted his attention as having indications of gold in or near it, and he took some samples of it. He asked Andy if gold had ever been found in the basin. Andy replied:

"No, Mr. Walsh, there is no gold in Imogene, except a little associated with silver or lead."

Mr. Walsh said:

"Andy, I believe there is gold in Imogene, and I am going to find it."

His samples of porphyry proved to assay \$2 per ton in gold, and that confirmed his suspicion.

Among the mining claims owned by Walsh at that time was one situated at about the same altitude about 300 ft. east from where he sampled the porphyry. He had never seen the workings of this claim, for a snow-slide that never melted covered the tunnel to a great depth. The idea occurred to him that a gold-bearing vein passed through or near the porphyry dike. Therefore he directed Andy to drive a tunnel through the snow and have samples for him on his return. Upon his return, Andy gave him two or three sacks of samples saying:

"These are what you asked me to get."

Something within Walsh, as he described it, said to him:

"Go and take your own samples. Remember, Andy has been in the basin for 18 years and has never found gold."

Arriving at the mouth of the tunnel, Walsh found a dump of very showy ore containing zinc, lead, and pyrite. Going inside and examining the vein, he found an 18-in. streak of the same kind of ore that was on the dump. Between it and the hanging wall there was three feet of modest-looking quartz. It had none of the shiny mineral in it, and looked so barren that the average miner would consider it no good but as Walsh examined it closely he saw little specks and threadlike circles of glistening black mineral all through it, which experience told him was gold in a telluride form. While he was sampling this grayish-looking quartz, Andy grew uneasy. Thinking that he did not see the metalliferous streak, he called

Walsh's attention to it, saying that it was the pay-streak. Walsh replied:

"Never mind, Andy; I always assay everything in the vein."

His samples from the common-looking rock ran as high as \$3000 per ton. Looking over the situation, he found that the men who had done the work, although they were no ordinary prospectors, had saved the showy low grade stuff and had thrown the modest but rich ore over the dump, from which Walsh afterward shipped it. This mine—the famous Camp Bird mine—produced millions. It was a strange coincidence that the bonanza part of the vein was immediately beneath the spot where Walsh picked up the piece of porphyry on the trail.

Cases of this kind in the history of mining in the United States may be cited in great numbers. This is why there arose in the minds of the administrators of mines during the last decade or two the advantage of having a corps of trained observers in the underground workings, men having nothing to do with execution of the mining work, which opened an entirely new field of employment to the young college graduate. The Anaconda company was the first to develop this system, as it has many others of great industrial importance. D. W. Brunton, who was then consulting engineer for the Anaconda company, remarked in a technical paper in 1906:

"In my judgment, every company operating large mines would find it advantageous to employ, as a separate official, a competent mining geologist, whose duty it should be to follow continuously all workings and surveys, and note with precision those indications which hard-worked superintendents, foremen and surveyors, however intelligent, might easily overlook or fail to record. The proper man for this most important work is a man who has nothing else to do, and will do this one thing with industry, enthusiasm, and technical knowledge."

Just the same thing may be said of mining operation. The efficiency engineer, with his time studies, is above everything else an observer. Of metallurgy, too, the same story may be told. What are our great steps in advance during the last 50 years? In copper, the principle of pyritic smelting, coal-dust firing of reverberatory furnaces, basic converting, and electrolytic refining. In lead, first of all, the knowledge of compounding proper slags, then the filtration of smoke, and finally the blast-roasting of sulphide ores. In gold and silver, cyanide lixiviation. In mechanical concentration, the flotation process. In no one of these cases was the progress the result of a lucky discovery. No one drew a grand prize in the lottery of success. Each one was the result of technical evolution. The germ of the idea dated back a half a century in some of the cases. Scores of investigators had played with it, some of them coming within sight of success. In most cases the thing needful was staring them in the face, but was overlooked through the human failing to observe accurately. When finally it was found everybody was amazed by the simplicity of it.

It is only in the metallurgy of fine that there have been

no major improvements that I think of, yet that does not disprove my point. The art of zinc smelting was transplanted from China to England. From England it was taken to Carinthia, Silesia, and Belgium. America got it from Europe. Both in Europe and America it remains today essentially as it was in China centuries ago and is there still. Our improvements have been in details, chiefly mechanical, the principle remaining the same. Yet it has been by observation that we have improved the art in its multiplicity of details and created a practice that China will some day copy from us, just as we first got it from China.

But it is not enough merely to observe. Observation is of no use without thought. Observation must also be accurate. Inaccurate observation and absence of thought may result in such erroneous deductions as happened from a freak of Jim Gillis of Jackass Hill in the gold diggings of California. Jim was Mark Twain's 'Truthful James.' In the early days the stage road passed Jim's house, or cabin I should say. The old miners used to make sour-dough bread, and Jim had some in a pan trying to make it rise, but it would not. So he said, "I'll make you rise, darn you." So he put the pan out under the oak that branched over the stage road, and put a stick of giant powder under it, and as a result the dough rose and hung all over the limbs of the tree. Just then the stage came along loaded with Eastern women and 'tenderfeet,' looking for curiosities in the gold-diggings. A lady asked Jim what kind of a tree it was. Jim, with a sober face, replied, "Madam, that is a bread tree." "Really, is that bread we see?" "Oh yes," said Jim, "you can take the dough in your hands and work it into bread." Whereupon she took some of it and believed, and told everywhere about Jim Gillis' bread tree of Jackass Hill.

Such imperfect observation and such errors in deduction have led to some very serious mistakes both in mining and metallurgy. Accurate observation and sound thinking have led to brilliant successes. The trouble with most of us is that we neither see nor think. Millions of men before Newton observed apples to drop, but so far as we know, nobody before him gave thought to what caused them to drop. I have no doubt that hundreds of mill-men 30 years ago, or more, observed greasy froths of mineral floating on their mill-water and thought nothing about it, except to pronounce it a nuisance. I happened to be connected with the introduction of the cyanide process in the United States 20 odd years ago. We tested in our laboratory all kinds of minerals and knew accurately respecting the solubility of silver minerals. In a refinery that we operated we produced silver bars from black precipitate coming from some place in Nevada where some one was cyaniding old mill-tailings. Yet none of us thought of the general applicability of the cyanide process to silver ores. That important industrial development came years later, although it was screaming for our attention. But our ears were plugged and our minds were saturated with ideas of gold.

Now it is for correct observation and sound thinking

that your college training has been preparing you. I think there is a certain mistaken tendency among engineers of middle age to depreciate the importance of technical training. You are probably conversant with a questionnaire recently addressed by Prof. Mann of the Carnegie Foundation to 1500 engineers, asking what to their minds are the basic qualities for engineers. The collated replies showed that 41 points out of 100 should be assigned to character, $17\frac{1}{2}$ to judgment, $14\frac{1}{2}$ to efficiency, 14 to understanding of men, and only 13 to technical ability. Dean Marston, of Iowa State College, applied these figures to six acquaintances with whose personal characteristics he was familiar, and found that the banker, the grocer, and the merchant rated higher as engineers than did three successful practitioners of engineering.

There is manifestly here a misconception. The engineers of mature years have seen technically trained men remaining in the background, while non-technically trained men, by virtue of their character, judgment, efficiency, and understanding of men, step in and take a large number of the important administrative positions. Take railroading, for example. It is rather a rarity to find a railway president who has risen through the engineering corps. And in mining and metallurgy we find a large proportion of our chiefs taken from some other line or some other industry. That 1300 out of 1500 engineers—87%—consider some one of the elements that go to make up character the fundamental necessity for engineering success does not mean that the average of these 1500 engineers would rate the elements of character as making up 87% of the necessary qualifications of an engineer. Not one of those engineers would think of taking a graduate of a business college as a technical assistant. Such a one would not even be able to understand the language. No, the meaning is rather, I think, that on top of technical training the elements of character are of supreme importance and that in course of time they outweigh everything else and are those things that make for success in any business man. The technical training is a ground work, and only a ground work. If we find fault with the product of our technical schools it is for their assumption, real or fancied, that technical training is the whole thing, that they are creating professional men, not merely business men.

Thus I come back to my theme—the business of mining. Mining is a business. It should be so regarded. You should consider yourselves as business men. You are not going to be any better or any worse than other business men. You are not going to have any professional dignity to uphold that the honest stockbroker or the conscientious manufacturer of woolen goods has not got to have in mind. Both of them may be just as honorable men in business as are miners and smelters. There is no greater fallacy than when it is told of the miner that he, like the farmer, is one of the producers of clean wealth for the reason that coming out of the ground it does not come out of anybody else, with the implication that other kinds of wealth are more or less tainted. The

value of minerals in the ground inherently is nil. One hundred million tons of gold ore in Antarctic lands might not be worth any more than sand in Florida. By the expenditure of work in overcoming the obstacles of nature, it might become worth a great deal. All wealth is the result of human labor, generally assisted by capital, which is the result of previous labor. The wealth accumulated by the Standard Oil Co. by economies in manufacturing and marketing is just as clean as the wealth that the miner produces out of the ground. The banker, the broker, or the merchant is just as necessary and just as honorable a man of business as is the producer, and men of business who talk in terms of profit are just as honorable as professional men who talk about fees and engineers who pride themselves upon not being concerned with commercial considerations.

The mistake that is most often made in business is to suppose that we grow rich by taking riches from other men, or that nations prosper by depriving other nations of their prosperity. That would be true if riches consisted only of money, and if there were just so much money and no more in the world. But that is not so. Nations grow rich, that is to say, get comfort, ease, and luxury, only when other nations are growing rich too, only because other nations are growing rich. And so it is with individuals.

Consider, therefore, that in going out into the world from this school you are going into business—the business of mining, which is a very interesting business. Consider that you are going into business to create wealth, for if you do not create wealth you will have a hard time of it and might as well not try it. At first you will probably have to make money for an employer and a portion of what you make for him will come back to you as wages or salary. The cycle may not be obvious. It may be delayed. But the principle exists and always will. You will see many things done in ways that by book they ought not to be. You will observe many examples of crude mining, of muscular metallurgy—less now than a quarter of a century ago. But if muscular metallurgy makes money and refined metallurgy does not, obviously muscular metallurgy is the thing to do, for otherwise there would be no bank account and on pay-day there would be gloom. Keep that principle in mind, but observe always and think whether by doing the right thing an improved metallurgy would not make *more* money. Look at things always from the standpoint of the business man and not from that of the pedant and doctrinaire. Rub against your fellowman. Build up your character. Don't be afraid to take chances and accept responsibilities. And when the battle is over, let your friends be proud to read an epitaph like this:

Here lies one who took his chances
In the busy world of men;
Battled luck and circumstances,
Fought and fell, and fought again;
Won sometimes—but did no crowing,
Lost sometimes—but didn't wail;
Took his beating—kept on going,
Never let his courage fail.

United States Mineral Production

The value of the mineral production of the United States in 1915, according to preliminary figures compiled by the U. S. Geological Survey, was approximately \$2,373,000,000, a gain of \$258,000,000, or more than 12%, over 1914. The value for 1915 has been exceeded but once—in 1913—when a total of \$2,432,000,000 was recorded.

The metallic products reached the greatest value ever recorded, having advanced from \$691,000,000 in 1914 to \$987,500,000 in 1915—a gain of nearly 43%. The metals contributing most largely to this increase, their combined gains being 91% of the total, are as follows: Pig iron, increase \$102,630,000, or 34%; copper, \$89,930,000, or 59%; and zinc, \$78,589,000, or 22 1/2%.

The value of the non-metallic products in 1915 has been exceeded in 1913 and 1914 only, showing in 1915 a decrease of less than 3% from the preceding year. The figures for 1914 and 1915 are \$1,423,000,000 and \$1,385,000,000, respectively. The final figures for the value of the non-metallic products in 1915 may be somewhat increased over the preliminary figures given.

The mining activities and output reported for the six months just ended show that 1916 promises to be a record-breaking year in the value of mineral products.

Coal Mining in 1915

The production of bituminous coal and anthracite in the United States in 1915 amounted to 531,619,487 short tons, valued at \$686,691,186, an increase, compared with 1914, of 18,094,010 tons, or 3.5%, in quantity, and of \$5,200,543, or 0.8% in value, according to C. E. Lesher, of the U. S. Geological Survey. Of this total output, 442,624,426 short tons, valued at \$502,037,688, was bituminous coal and lignite, and 88,995,061 tons, valued at \$184,653,498, was Pennsylvania anthracite. Pennsylvania, with an output of 157,955,137 tons of bituminous coal and 88,995,061 short tons of anthracite, ranks first among the coal-producing States. West Virginia, with 77,184,069 tons; Illinois, with 58,829,576 tons; Ohio, with 22,431,691 tons; and Kentucky, with 21,361,671 tons, follow in order of production. Thirty States and the Territory of Alaska contributed to the total, 8 which number 13 States and Alaska had increased production, and 17 had decreased production, compared with 1914. To produce this coal, 731,008 men were employed for an average of 209 days.

THE VALUE of the base metals recovered from scrap in the United States during 1915 was double the value recovered in 1914, being \$111,919,230 against \$57,039,706. This was due to the higher prices received for these metals, and the consequent stimulation in the gathering of junk.

Concrete Stringers for Inclined Shafts

At a recent meeting of the Chemical, Metallurgical and Mining Society of South Africa, the concrete shaft equipment at the Bantjes Consolidated mines was discussed by W. W. Lawrie and G. Jildick Smith. As is well known, longitudinal concrete stringers for inclined shafts are a substitute for timber sills. They have been used in North America, notably at the Lake Superior copper mines and the Sudbury nickel mines. At the Bantjes shaft on the Rand, the incline is 34°, the track gauge is 4 ft. 2 in., and the rails are 60 lb. per yard. The three interior stringers each carry two sets of rails and are 2 ft. 9 in. wide at the top, the angle of batter of the sides being 65°. The two outside stringers are 1½ ft. each. The thickness or height of stringers varies, of course, with the irregularities of the foot-wall, but is usually 1 ft. 9 in. The building of the stringers in the shaft is done from the bottom upwards. The holding-down bolts for fastening the rails to the stringers were placed 6 ft. apart at first, but later were spaced at 4 ft. One white man and nine natives can build an 18-ft. section of concrete in a shift, making the cost for labor 63c. per foot of stringer. Ten bags of cement are required per 18-ft. length of stringer, making 86c. per ft. for cement. The cost for labor and cement is, then, \$1.49 per foot of stringer or \$7 per foot of shaft. The equivalent cost of timber sills on the Rand, as exemplified at the Nourse mine, is about \$12 per foot. In other words, concrete stringers on the Rand are 43% cheaper than timber sills. This is due largely to the high cost of timber there, as the material of the timber stringers costs more than the labor for framing and placing them. On the concrete stringers, the rails rest on thin steel plates bedded in the concrete at 4-ft. intervals at the holding-down bolts. Strictly speaking, the rails only touch these bedding-plates, but in practice the space between the concrete and the chair of the rails soon becomes filled with fine dirt.

The conclusions reached were: that concrete stringers are preferable to timber stringers in incline shafts up to 45° provided there is no movement of the foot-wall of the shaft; skip derailments do much less damage with concrete than with timber; for shafts from 45 to 60°, concrete stringers could be held in position by pegging the foot-wall at intervals.

At the Creighton mine of the Canadian Copper Co. in the Sudbury district of Ontario, a shaft of 55° incline is fitted with concrete stringers. Skips of 10-ton capacity are used. It was not considered safe to place the rails directly upon the concrete stringers, so steel girders were set in the concrete at 7½ ft. intervals for sleepers. Rails of 85 lb. per yard, 3½-ft. gauge, were attached to them, a bit of belting being placed between the base of the rail and the top of the girder. The concrete stringers are 3½ ft. wide and run down the centre of each compartment. These data on the Creighton mine were fur-

nished in discussion of the above paper, by H. Foster Bain who was a visitor at the meeting of the South African society.

In the Lake Superior copper mines concrete stringers have given good satisfaction after several modifications were made from the original design. These modifications included: changing the design of holding-down bolts so that the head is exposed at the side rather than on top of the stringer; employing wooden plank laid longitudinally between the concrete base and the rail to reduce the 'hammering' and noise produced by the bare concrete, particularly in steep shafts of 70°. The jarring on bare concrete stringers made considerable breakage on the skip as well as wear of the bolts in the concrete. Wooden cross-pieces may be used as a cushion.

Early History of Spelter

Spelter was first made in England in the early part of the eighteenth century, but the industry was destroyed by the merchants and importers of Preston, who reduced the price from £260 to £48 per ton (56 to 11 cents per lb.) when their interests were threatened. William Champion was one of the first English manufacturers of spelter, previously imported from India. He had his works at Warnley, a freehold property bequeathed to him by his father. On February 21, 1750, Mr. Champion presented a petition to the House of Commons in which he stated: "That he had spent a great portion of his life traveling abroad, and on his return to England had found the supply of 'tontorage,' commonly called spelter, dependent on the East Indies. Ingrossers had raised the price in 1731 to £260 per ton, and he applied in 1731 for a patent for making 'tontorage' or spelter, and this had expired in 1750. He had erected large premises and made 200 tons, when the importers brought in a large supply, and lowered the price from £260 to £48 per ton, at a supposed profit of £22 to £25 per ton to the importers. Not being able to procure such prices for his spelter as would admit of profit, he was a great sufferer, and he therefore prayed for an extension of his patent." The petition was opposed by traders of Preston and was rejected. It appears that brother of the petitioner, John Champion, in early life went to Holland, there representing himself as a beggar, and got employed there as a laborer during which time he learned the secret to make brass and zinc. When he left he induced several workmen to return with him to England, and with them he set up the works for the production of metal at Warnley. —*Daily Metal Reporter*.

By-products from coke-oven operations in the United States during 1915 were valued at \$78,382,904. These included ammonia, benzol products, and gas—domestic and industrial.

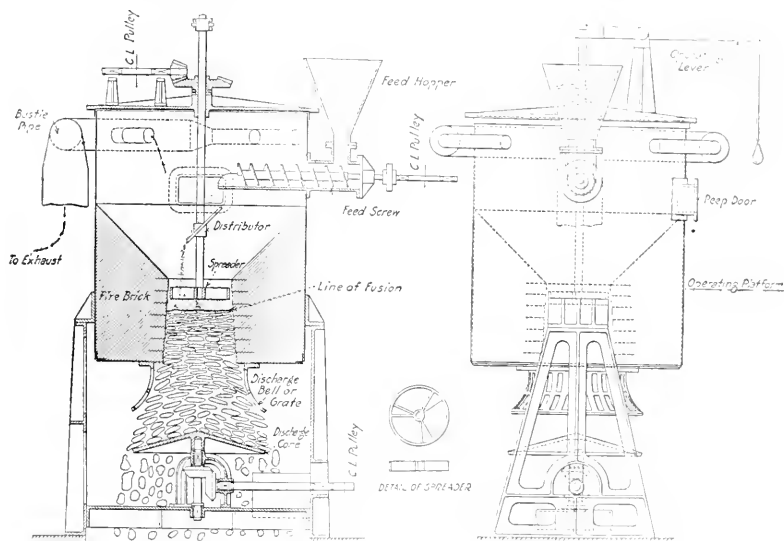
BRICK AND TILE manufactured in the United States during 1915 were worth \$125,794,844, a decrease of 3% compared with the output in 1914.

A Continuous Ore-Sintering Machine

*This machine was designed by P. O. Harding, now with the Braden Copper Co. in Chile, to treat iron ores, and is the result of a study to avoid the burning and clogging of the grate, so detrimental to sintering methods, and to overcome the operating difficulties and expense of igniting successive charges. Other features developed are the tapering tube and the protection of all parts subjected to heat.

From the illustration it will be noted that the machine is screw-fed. The mixture falls to the distributor, and is in turn further distributed by the spreader and

down rapidly, resulting in a burned grate. To effect a screening action of the air, preventing the fine ore from being drawn through the grate, finely-broken limestone is used. This readily dehydrates, as mentioned above, and powders; the grate in this way becomes clogged. In large sintering pans it is customary to 'dig out' the grates after each charge, and to place bricks or large chunks of sintered ore over the burned spots. This is continued until the grate is burned in a sufficient number of spots to cut the effective area to a point requiring replacement.



SECTION AND GENERAL VIEW OF THE HARDING CONTINUOUS ORE-SINTERING MACHINE

pusher. Air is drawn through the tube to the bustle-pipe by an exhauster. The clinkered material descends and is discharged by the extractor to the cars or storage-pit below.

The burning of grates in the down-draft machines is caused by the line-fusion progressing in waves. This may be caused by poor mixing or segregation afterward, and by uneven moisture-content of the mixture. When the peak of such a wave reaches the grate, the operator has his choice between a burned grate or dumping the charge before the mass is entirely sintered; he generally compromises. It is the common practice to protect the grate by a layer of limestone. Unfortunately this method acts as a barrier for only a short time. The heated gases from the combustion above dehydrates it, and where the hot masses of clinker come in contact insulation is broken

As to the ignition, this is continuous in this machine after the operation is once started. No oil is used and burner difficulties are obviated. The cost of oil and the expensive equipment of handling it are thus saved. The flaring-tube not only facilitates the downward passage of the clinkered material, but opens up channels for the passage of air. The clinkered ore is scoured of its dust, and small globules of unfused ore are thus swept back to the zone of fusion. This is important, since experience on unscreened sintered ore in one instance yielded 5% flue-dust at the blast furnaces, the untreated ore only 2.95%.

The pan equipment of the down draft process is subjected to wide variations of temperature. This is extreme, as the volatile content of the flue dust is carbon. This, together with the fact that one of the favorite methods of cleaning the grate is by violent hammering,

*Abstract from *The Iron Age*.

causes the pans to crack. This is applicable to the small pans. The grates of the larger units are 'dug out,' as mentioned, but contraction and expansion difficulties of the pans have been encountered that have not successfully been met.

In this machine the fire-body is enclosed by fire-brick. After the discharge-bell and cone reach their working temperature, this is maintained. They are circular, and therefore admit expansion with minimum internal stresses. The spreader is bathed in the green 'entering' mixture. If the line of fusion should become uneven and burning through the mixture necessary, the spreader can be raised. One feature not to be forgotten is the use of the spreader as a ram when the tube becomes skulled or the clinkered material arches.

The Future of Silver

Our esteemed contemporary *The Financial Times* (London) says:

A little over two months ago the continued rise in the price of silver, which had then reached 37d. per ounce, was threatening to raise serious complications, particularly for the Indian Government, which is pledged to maintain the fixed rate of exchange of Rs15 to the sovereign. By one of those queer turns of fortune's wheel, to which we are becoming accustomed in these disturbed times, the danger was averted just when it became most critical, and the Indian Government was not obliged to take any extraordinary measures to protect itself. The relief came, however, from a source which threatens further difficulty later on. Apart from minor factors, the main cause of the reaction, which has brought the price of the metal down to 30d., has been the selling of accumulated stocks in China, mainly owing to the political uncertainty in that chaotic Empire, and there is some reason to believe that the process has been carried so far as to endanger the currency system of the country. In spite of the high prices ruling there has been comparatively little increase in the production of the metal recently, except in the United States, and this has not in any way compensated for the shrinkage in the output from Mexico. Conditions in the latter country have gone from bad to worse and show no signs of improvement, and in any event it will be a very long time before confidence can be so restored that the output from the mines will be resumed on its former scale. In the meantime the employment of silver for currency purposes continues to increase owing to the withholding of gold from circulation, and the tendency is likely to continue for some time even after the War has ceased. It has even been suggested that after the War Germany and Austria may go upon a silver basis, and though we consider this extremely unlikely, the fact that the possibility is being discussed is in itself significant.

There does not seem therefore to be much likelihood either of a material increase in the output of the metal or of a shrinkage in the present abnormal demand, and

While thorough mixing of the ore and flue-dust is essential for the best operation of the machine, this need not be carried to an extreme, as is necessary with the down-draft equipment. However, a batch concrete-mixer is recommended. The flue-dust addition to the ore varies, but 20% of the 25% carbon-content dust has been found to give good sinter. The dust, however, can be increased, but care must be taken to keep the dilution to a point that excessive skulling does not occur. Sufficient water should be added in the mixing to make the ore take the shape of the hand when squeezed. The diameter of the tube should be 6 ft., height of column 3 ft., and estimated output 125 tons of sintered ore per day, these being the measurements that have been found to give best results.

there are obvious limits to the continuance of the drain upon the stocks of silver in China. As Samuel Montagu & Co. point out in their latest circular, the permanent currency requirements of China cannot be overlooked. At present they are in abeyance owing to the moratorium and the general unrest, and this has facilitated a steady secret flow of silver into the Treaty Ports. How much silver China has parted with during the last year and a-half can only be guessed at. Samuel Montagu & Co. put the shipments on Russian account during the eighteen months at 13,000,000 ounces and those to India and London at 20,000,000 ounces, making a total of 33,000,000 ounces. "No one," they go on to add, "at all conversant with the currency requirements of China can imagine that that country can dispense with so large an amount of its stock for any great length of time, for in normal times China attracts annually an amount of the world's supplies which compares appreciably with the total lately disgorged."

The conclusion is obvious that if and when confidence in the Chinese Government is restored she will become a heavy buyer instead of a seller. Even as it is, no further large quantities of the metal can be expected from that quarter, while there is no evidence of any real slackening off in the demand for coinage purposes. There seems, therefore, every prospect of the market remaining firm while the possibility of a fresh sharp advance taking place should there be any marked improvements in the internal conditions of China cannot be ignored.

THE VALUE of the materials that contain manganese depends largely on the percentage of metallic manganese, and also both on the manganese minerals present and the condition or state of aggregation of the material. This is for use in making ferro-manganese. The consumption of manganese in dry batteries is 20,000 tons annually. The value of an ore for this purpose depends on its manganese-oxide content. Caucasus ore contains up to 92% MnO_2 .

GOLD AND SILVER production of New Zealand in 1915 was valued at \$6,562,422, against \$7,799,291 in 1914.

Mining in Colorado

By George J. Bancroft

Throughout the summer months mining in Colorado has made steady advancement in spite of the fall in the price of the metals. In fact, one of the gratifying elements in recent mining progress is the total absence of a 'mining fever.' The mining that is being done nowadays in Colorado is done for the most part by mining people, not by 'tenderfeet,' and mining people base their plans on average metal prices, not on war-time quotations. For instance, the Vindicator people have gone into tungsten mining and milling in Boulder county.

As predicted some months ago, the quickly made money from the Boulder tungsten districts is supplying capital for neighboring counties. Gilpin has more men at work this summer than for several years and this condition exists in spite of the fact that a large part of her population is still busy digging tungsten in Boulder. That county, of course, is flourishing beyond belief. The slump in tungsten came just at the right time from a public standpoint. The sellers of stock were just beginning to get the "dear public" to buy tungsten shares when the slump came. I do not know that any of these shares sold were bad. In fact, such movements generally start with fairly conservative enterprise, but I think it much better for the mining industry and a whole lot better for the "dear public," if mining speculation is confined to those who understand the game.

Tungsten is still being bought and a good price is being paid for it, but what that price is, it is hard to determine. Unfortunately the tungsten market has degenerated to a horse-trading affair. In spite of this demoralized market, money is rolling into the tungsten fields by the cart-load and the accumulated capital is to a large extent being used in mining ventures of various sorts. As result Boulder, Gilpin, and Clear Creek counties are active along intelligent and conservative lines.

George H. Barnhart of Ouray is building a unique mill, for it is placed underground. The Mountain Top mine has some good ore but it is situated, as its name implies, on the very top of a precipitous peak in the San Juan. There was only one feasible outlet apparent to everybody and that was to connect with the long adit of the Atlas mine (above Ouray) and tram the ore out that way. Even then it meant building a long surface tram. Barnhart conceived the idea of building his mill underground, close to his orebodies. Thereby he obtains an equitable temperature and a closely concentrated operation. The light may not be very good on the day-shift, but at night it will be just as good as it would be outside. He is installing a crusher, ball-mill, two Wilfley tables and a flotation plant. The mill will be driven by electricity; it is about 12,500 ft. above sea-level, and will have an initial capacity of about 50 tons.

Altogether about thirty flotation plants have been installed in Colorado. Of these about one-half are successful. The failures of the other half might be more in-

structive than the successes if one could be sure they had any ore to work on. Two instances, which I went to some pains to investigate, turned out to be mills built for mines that needed an alchemist, not a common metal burglar.

Several interesting points are illustrated by the four big pumping projects now under way at Leadville. Within the last thirty years underground pumping has been done mostly with steam-actuated reciprocating pumps. Prior to that time there were a good many Cornish pumps in operation. Of the various types all have their advantages and disadvantages, but no one type has proved good enough to displace the others. Operations at Leadville have demonstrated a distinct and measurable advance in pumping and hence are worthy of special consideration.

The two pre-eminent steps are the use of centrifugal or turbine pumps, and the driving of the same by an extended vertical shaft. The rotary type of pump is far less heavy and cumbersome than the reciprocating type. It is, therefore, much easier handled in the shaft. The idea has prevailed that centrifugal pumps were limited to low heads, but this difficulty has been overcome by treating the water in several 'stages.' The discharge of one stage is the intake of the next, and in this way pumping-lifts of several hundred feet may be effected. I notice, however, that relay-pumps are still used in high lifts where centrifugals are employed. Of course, the cost of one high-pressure water-column and one high-pressure turbine may be greater than the cost of two low-pressure water-columns and two low-pressure turbines. Then again a mine does not always get all the water on the bottom level. It is often possible to halt the natural downward flow of water at some level that has a fairly good bottom, and connect it direct to an intermediate pump. These considerations, no doubt, had their bearing in designing the Leadville plants, for the greatest single lift is 425 feet.

The advantages of an extended vertical driving shaft are obvious to anyone who has worked with electricity in a wet mine. The farther the motor and wires can be kept from water and drip, the better the manager can sleep at night. The motor actuating the centrifugal pumps is 12 ft. above the intake. Supposing the pump is set 5 ft. above average water-level, that gives 17 ft. of fill before the pump is dead. The turbines have 200 ft. of vertical shaft. They call them 'shoe-string' pumps for this reason, but are thoroughly practical. I designed a pumping plant some years ago for a mine in New Mexico, in which the vertical revolving shaft extended clear to the surface. The relative cost of installing and operating an electrically-driven rotary pumping-plant in the Leadville district is said to be about one-half the cost of a steam-operated reciprocal pumping plant of the same capacity.

The four large pumping schemes at Leadville have been described in previous issues of the Press. The Down Town project and the Iron Hill are using centrifugal pumps. The Leadville Unit and the Wolfton are using 'shoe-string' pumps.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

BARITE or barytes is barium sulphate; baryta is barium oxide.

THE TIMBER used in building the power-plant at the De Beers diamond mines in South Africa several years ago was brought from the Pacific Coast of North America, and cost \$1 per cu. ft. or \$85 per thousand board measure.

PLATINUM has declined from \$100 per oz. early in 1916 to \$64. Before the War it was \$42. Most of the platinum comes from Russia, where production fell from 300,000 oz. in 1912 to 124,000 oz. in 1915. Colombian mines in the period increased production from 12,000 to 19,000 ounces.

FUMES from blasting are generally worst when unexploded butts of dynamite are found in the broken rock. This shows that instead of detonating properly the powder merely burned. At such times unexploded sticks of dynamite may give trouble in the crushing of the ore on surface. These conditions may be corrected by using stronger detonators.

THE ACID used by the New Cornelia Copper Co. at Ajo for the leaching of oxidized copper ore will be furnished from the Calumet & Arizona smelter at Douglas, where it is a by-product of the reduction of sulphide copper ore. A large amount of lead was recently bought for lining the leaching-vats. Sulphuric acid of 9% strength will be used to leach the ore crushed to $\frac{1}{2}$ -in. particles.

ORDINARY SOCKS are not worn by German soldiers, it is stated. They use a square cloth somewhat larger than a large napkin, which can be wrapped around the foot in 30 different ways, according as it is desired to protect any particular portion blistered by long marches. This method of encasing the foot for the wear of heavy boots is well known to miners, many of whom prefer the square cloth to socks.

THE LONGEST horizontal diamond-drill hole that has been drilled on the American continent is believed to be 1870 ft. bored at the Quincy copper mine, Michigan, by the E. J. Longyear Co. of Minneapolis. The deepest core-drill hole in America is claimed by the Sullivan Machinery Co., which has drilled a hole 4900 ft. deep. Depths as great as 6900 ft. have been attained by drill-holes in South Africa.

WELL DESIGNED TRAM-CARS and good tracks are essential for an underground electric-haulage system. In a mine of the Moctezuma Copper Co., Mexico, a 3-ton locomotive could pull only five loaded cars, each of 20 cu. ft. capacity, when equipped with regular 'Anaconda' axles,

without the wheels slipping. But with cars equipped with roller-bearing axles, the same locomotive pulled six cars of 22 cu. ft. capacity each.

MAGNESITE BRICK of high quality was \$150 per 1000 prior to the War; now it is \$600 to \$650, for large lots. A recent export order for 20,000 at New York was quoted at \$775. Dead-burned magnesite is selling at \$80 per ton. All Austrian supplies are cut off. Considerable Grecian ore is coming to this country. In making magnesite brick the great problem is in burning. American ore is not the best for this purpose as it does not contain sufficient iron, a fault some makers are trying to remedy by adding rolling-mill scale.

IN WIRE-ROPE practice if it is desired to secure a sample from a coil of wire and not having a pair of cutters, the wire is bent backward and forward until it breaks at point of bending. It is surprising how few reverse bends are required to cause failure, and it should clearly demonstrate that if the wire in a rope is subject to similar reverse bends short life will result. The average user of wire rope is fully aware of this, and doubtless has secured samples in a similar manner; yet, how few stop to consider that if their sheave equipment is arranged to subject the rope to this reverse bending they cannot expect maximum rope service.

MOLYBDENUM is a white metal, malleable, ductile, and soft enough to be filed with ease. However, it is seldom produced in the pure state. Its melting-point is in question, although the U. S. Bureau of Standards places it at 2500° C. or 4500° F., which is 1400° C. above the melting-point of copper. Tungsten is one of the few metals that have a higher melting-point. The appearance of molybdenum varies with the method of making it; reduction of the oxide or sulphide by hydrogen, yields molybdenum as a grey powder, which, under heat and pressure, may be compacted into a brittle metallic bar. When drawn into wire, its tensile strength increases with the fineness of the wire. In other words, as with copper and tungsten, the more the metal is worked the stronger it becomes.

DROWNING a mine-fire in Michigan is being done in a thorough manner. The Dober mine, a large underground iron mine of the U. S. Steel Corporation at Iron River, has been burning for five years as a consequence of pyrite in the ore. Several months ago, the gas and fumes from the fire became so bad that nearly all work had to be stopped. An unsuccessful attempt to control the gas by a ventilating blower drove sulphur fumes among the residents around the mine. Now the management has decided to draw temporarily the pumps and machinery from the mine and divert Iron river, a good-sized stream, into the workings. Three days will be needed to fill the mine with water, and 2,000,000,000 gal. will be required. After the fire is extinguished, the mine will be unwatered and mining resumed.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

CONDITIONS IN THE ZINC-LEAD REGION DURING JULY.

The month of July in the zinc-lead mining districts of south-west Wisconsin will be recorded as one of the greatest periods in the history of the region. In shipments of zinc ore, especially with highly unsatisfactory market conditions, a high point was reached. Reserve stocks of zinc concentrate are large. Six new mines, developed within the past half-year and brought up to the producing stage by erection of elaborate equipments, commenced regular operations. Prospecting with drilling machines, the Keystone steamer type prevailing, reached a high point during the month, some operators being engaged with as many as 15 machines each. Rich strikes of zinc ore in virgin soil were numerous, and many areas mined successfully for years were checked up, bringing extensions into existence on adjoining lands which were promptly secured by mining lessees. Building operations continued at all points, 15 new plants being completed. Eighty fully-equipped mines contributed to the production during July, and 10 zinc-ore "refineries" operating at maximum capacity enabled the field to deliver to smelters direct over 12,000 tons of standard 60% commercial zinc concentrate. The zinc-ore refining branch of the industry will be materially enhanced in the near future by the construction of two, and perhaps three, new plants, one of which is to be the largest in this field. This plant is proposed for the Benton district by Indianapolis business interests now largely involved in mining in this field, the purpose being to include all low-grade zinc-ore producers. The new project is to be capitalized at \$500,000, stock to be taken by the companies becoming a factor in the undertaking, and to be paid for at the rate of \$1 per ton deducted from the sale of finished product. Small operators will be permitted to negotiate loans, enabling them to become active shareholders at a low rate of interest. It is proposed to employ the McDougal type of furnace with a total capacity of 200 tons of raw ore per 24 hours. The new plant will cost complete \$200,000.

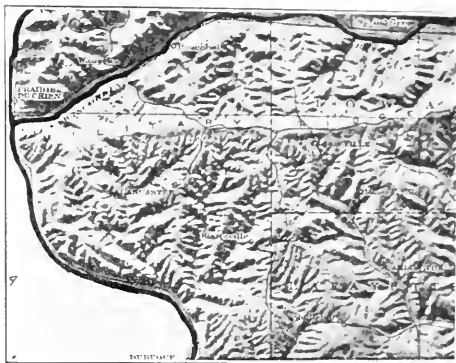
Prices on zinc ore held nearly all month at \$60 to \$68 per ton, base of 60% zinc for top grades, while on seconds and medium-grade ore the base fell as low at one time as \$53 per ton, including down to 50% zinc-content. Some gain was made at the close of the month, inferior grades being brought up to \$58 per ton base, at which price shipping increased. All low-grade producers, and in this class were delegated all ores under 50%, suffered sharp discrimination in price, many being unable to market their output at all.

Lead ore was in poor demand all the month, and shipments were light. A fair gain was shown in production for the entire field; much of this class of ore being carried over. Prices were unsettled, offerings at the beginning of the month holding at about \$75 per ton, receding to \$70 per ton for 80% metal-content when the month closed.

Shippers of pyrite, and this includes nearly all zinc-ore refineries now in operation in the field, experienced another disastrous month. High prices prevailing for spot acid enhanced the demand for high-grade sulphur from the Louisiana deposits and high-grade pyrite. The average Wisconsin iron pyrite contains, on the general run of fine secured from separating-plants, less than 50 units, and with the exception of one or two shipments of note during the month nearly all the

current production and the reserve of the previous month was carried over. A careful tabulation of this class of ore held in the field at the close of the month was in excess of 6000 tons, and there was absolutely no sign that the situation would be in any manner relieved for a long time.

Producers of carbonate of zinc ore, buoyed up by a false hope early in the month that a buying season had set in, ac-



TOPOGRAPHIC MAP OF WISCONSIN ZINC REGION

celerated production, and a fair quantity was prepared for market. Such shipments as were reported came mainly from the mines of the New Jersey Zinc Co. in the northern centres. The price held strong at \$10 to \$50 per ton, 40% metal-content but sales were light, a little over 1,000,000 lb. A considerable reserve was piled-up and carried over.

Ore deliveries totaled 54,288,000 lb. of blende, 689,250 lb. of lead, and 4,533,500 lb. of pyrite.

LEADVILLE, COLORADO

PROSPECTS OF THE LACKAWANNA-HALFMOON DISTRICT AND THE HILL MINES.

It is no longer doubted that the Leadville district has an other rich and extensive gold-belt in the territory comprising the Lackawanna-Halfmoon section. The remarkable success of the Mt. Champion mine at the head of the Lackawanna gulch, together with the data gathered by geologists who have made a thorough study of the formations, mark this western corner of Lake county as one of the most promising mineral areas in the State. J. V. Howell, assistant professor of geology at the State University of Iowa is now in the Lackawanna territory completing work that he has been two years doing. He has covered Mt. Champion, the location of the Mt. Champion mine, Casco mountain, and Sunset mountain. He is now extending his work to Hunter's pass. Starbuck and Adair mountains, where several rich ore shoots have been discovered. Mr. Howell is greatly impressed with the possibilities of the ground, stating that the outcroppings of veins which are numerous, are richer and stronger in many cases than that of the Mt. Champion mine. The geological work in the Lackawanna

section is being done by the State of Colorado under the supervision of Russell D. George of the State University and head of the State Geological Survey. During the past month he spent several days in the territory looking over many points of interest, and noting the progress of the work under way. He endorsed Mr. Howell's impression of the area, and added that it is to be regretted that prospectors have turned their attention to other fields and neglected the Lackawanna-Halfmoon section with its promising indications. He also inspected the Mt. Champion mine, and considered it a wonderful gold producer with well-defined and extensive orebodies.

The Mt. Champion is the only large active property in Lackawanna, and at present is one of the richest producers of the Leadville district. The mine is near the head of Lackawanna gulch about 18 miles from Leadville, on the south-western slope of Champion mountain. A new 100-ton mill has been erected on Halfmoon gulch at the foot of the northern slope of the mountain, one mile from the mine. A tram conveys the ore from the mine to the mill. Last month the mine shipped approximately 300 tons of concentrate valued at \$100 per ton, and several bars of gold, making the total yield \$40,000. A large vein has been cut in the mine, and is being extracted through three adits. The work that has been done on the vein has opened the ore to a depth of 300 ft., and the deepest development shows the vein to be persistent. Fifty men are employed at the mine and mill.

Lessees have taken charge of the Lackawanna Belle property on Sunset mountain, and the latest report states that a vein of rich gold ore has been cut in the main adit, and is being followed with good results. This property has produced a large quantity of rich ore from workings on and below the adit-level. The vein was lost in the main adit, and water forced the abandonment below, resulting in closing the property. The uncovering of the vein again indicates the continuation of the rich ore-shoot ahead, and extensive development is contemplated. Should the ore prove up to expectations, another adit will be driven in to the vein from the bottom of the mountain, a piece of development that will give unlimited stoping ground and do away with water trouble. All the ore that has been taken from the Lady Belle netted over \$100 per ton.

Other discoveries of rich material have been made in the Lackawanna district, and before the winter suspends surface work many veins may be found. Prospectors recently located a vein on the south side of Lackawanna peak, where the outcrop showed a brown honeycomb quartz that assayed 53 oz. of gold per ton. The development of this vein is now being rushed by locators who have traced it for some distance.

Mining men must now begin to turn away from the old and developed centres and seek new fields for exploitation. Present operations, which continue development of the old mines, are at the high expense of draining and sinking, items that were inconsiderable in the early days when ore was found at the surface. The work now being done through the Penrose, Harvard, and Wolfstone, and that proposed for the Mikado, has been successful in removing the water from the greater portion of the district, but it has cost a large sum. The returns for this expenditure should be great and undoubtedly they will be, providing a high metal market prevails for several years. But it all goes to show that the new mines, the rich mines of the future, must be sought away from the present centre of activity. The Lackawanna-Halfmoon section is extensive and rich, and awaits the time when mining men will fully understand its value and turn their attention to its development. The only drawback to the section is its isolation from transportation, being 18 miles from the nearest railroad siding. Prospectors prefer to work nearer home, it seems, and for that reason more than any other the wealth of this ground has not been discovered.

The manager of the Leadville Unit (U. S. S. R. & E. Co.), H. S. Lee, operating the Harvard and surrounding properties

on Fryer hill, has a new problem to solve before the ground is drained. It appears that after the Harvard shaft was unwatered several weeks ago, water rushed in from supposed workings on the lower level and blocked plans for installing a station pumping-plant at the bottom of the shaft. This flow, instead of being a temporary flood, continues to run in, and its source was not known until recently when the manager, on an inspection tour, discovered an old raise near the western boundary of the mine, where a large water-course has broken through and was pouring into the lower workings. The water was at once known to be from the surface, and could come from only two sources; the stream running through Evans gulch or the reservoir in the gulch just above the Harvard. The reservoir, however, was there when the Harvard shaft was sunk and no water trouble was then experienced. So unless water-courses have gradually worked their way through the interlying formations, the water does not come from the reservoir. The stream is the only remaining factor and steps have been taken to prevent further trouble from that direction. A large flume is being built through $\frac{1}{2}$ mile of the gulch above the Harvard to carry off the water. Mr. Lee states that this work will cost \$2000, but it will effectively block any channels whereby the water has been running underground and in time will more than pay for itself. Aside from the draining, the operations of the Leadville Unit are progressing in a satisfactory manner. Large bodies of high-grade carbonate of zinc have been opened in the Tip Top shaft, and three shifts of miners are extracting ore. The property is now producing 50 tons per day, and the output will be increased from time to time.

Plans are complete for re-opening the old Fitz Hugh property, also controlled by the Leadville Unit, and rated as one of the big mines of the district, now that the water has been drained. Other extensive developments in this territory are proposed, and the coming month should see a heavy production from the mines.

The Wolfstone shaft of the Western Mining Co. is now drained to the 1000-ft. level, where the old steam pumping machinery is again at work, handling the flow from this point directly to the surface. The shaft is being re-timbered, which until recently was under water. Following the shaft work it is planned to drain the remaining 100 ft. to the bottom, and probably sink still deeper. The property continues to ship 350 tons of high-grade carbonate of zinc daily.

Discussing the low price of Alaska Gold shares—\$16—the *Boston News Bureau* considers that this is due to the low value of the ore treated. In the year ended December 31 last there was treated 1,115,294 tons of ore averaging \$1.15 per ton, with tailing losses of 21.9c. per ton. It so happened that for the eight months ended July, including December 1915, the tonnage treated and the average grade of ore were practically the same as for the period covered by the annual report. For the eight months referred to, ore treated was 1,176,097 tons of an average grade of \$1.17 per ton. If losses in tailing be estimated at 22c., the net recovery was 95c. This compares with \$1.50 net recovery estimated when the company was formed. In 1915 average mining, milling, smelting, and miscellaneous costs were 71c. per ton, not including all development. It is safe to say, however, that even as at present operated, Alaska Gold is earning its current expenses and interest on \$3,000,000 bonds, but probably not much more than this. Returns are as follows:

	Tons	Assay value
December 1915	114,183	\$1.36
January 1916	119,914	1.42
February	122,856	1.02
March	162,796	1.03
April	165,930	0.94
May	175,215	1.40
June	164,800	1.06
July	150,403	1.24

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled for the Mining and Scientific Press

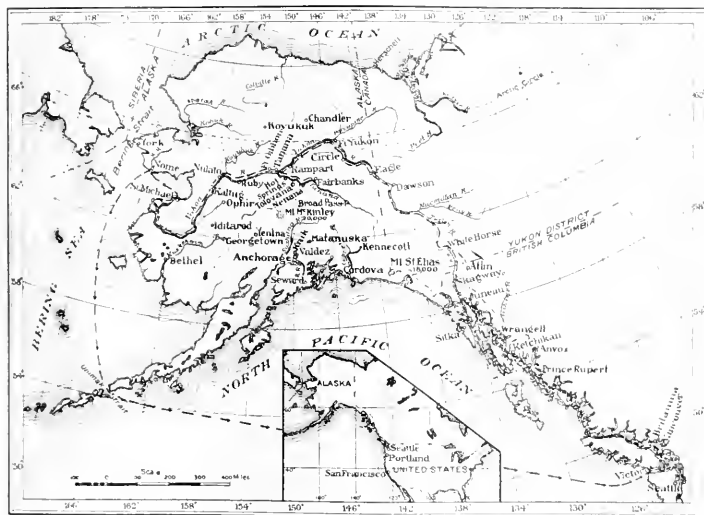
ALASKA

The Alaskan mining industry in 1915 is detailed by Alfred H. Brooks and others in Bulletin 642-A of the U. S. Geological Survey. With a map the publication covers 71 pages. Twelve parties were engaged on surveys and investigations, the season varying from 3 to 8 months. Reconnaissance surveys covered 10,700, and detailed geologic survey 200 sq. miles. The areas included south-eastern Alaska, Copper River basin, Prince William sound, Cook Inlet-Susitna region, Yukon basin, Yukon-Kuskokwim region, and a general investigation. The

had been placed on other duty. The suspension of operations at the mills has caused even less disturbance than had been anticipated.

ARKANSAS

RUSH. It has recently been published by Thomas Shiras of the north Arkansas mining district that the producers of that region have thrown away into the tailing piles an average of 4% ore in the last 12 months. This is but one of the many mistakes due to lack of working knowledge which have led to many failures in the early history of the field. Some of the tailing-piles have been found to contain as high as 8%. In an interview with J. C. Shepherd, of Rush, who is the largest producer in the field, he states that a saving of all but slightly over 1% is possible. He has been experimenting for some time on this problem and at present is engaged in building a 200-ton tailing-plant, through which to treat his 25,000-ton dump, as well as all chats coming from his concentrating plant. Mill construction during the early days of the district was poor, as far as it pertained to high recoveries. Few mills had tables or even hand-jigs. Carbonate and silicate ores do not have as high a specific gravity as blende, and in some instances the lighter ores are so closely interwoven with lime that unless ground fine complete recovery is impossible. The mineral is lost in both the fine and the coarse tailing. A radical change in mills has been made during the past few months. Tables of the Wilfley type have been installed, also hand-jigs and additional rolls; the loss generally



MAP OF ALASKA.

appropriation was \$100,000. The mining industry of the Territory was more prosperous than in any previous year, the total mineral yield being \$32,854,229, against \$19,065,666. This great increase was due to \$12,286,195 from copper, and \$937,885 from gold. Considerable attention was given to antimony deposits. The Tolovana district attracted many men. Several pages are devoted to the coal situation, including leasing.

ANCHORAGE. Six miles north of the Gold Bullion mine, J. Garber has uncovered rich gold ore at the head of Paterson creek, in the Willow Creek district. He has been at Anchorage recording his claims.

JUNEAU. On August 1 the 240 and part of the 300 stamp-mills of the Treadwell company were stopped. This started rumors on Douglas Island that the mines were to suspend work for some time. The superintendent, P. R. Bradley, states that there is no foundation for the rumors. He stated further that the shutting-down of the 240-mill and half of the 300-mill had resulted in a process of re-adjustment of labor, rather than in the actual letting out of men; that many of the workmen from the mills had been placed in other departments of the mines, so that the actual number of laborers out of employment, as a result of the suspension of operations at the mills

hereafter will be small.

YELLEVILLE. According to J. H. Hand shipments from the north Arkansas zinc-lead field in July totaled 75 carloads. Many producers are holding their ore for better prices.

ARIZONA

BISBEE. A 5-compartment shaft is to be sunk 1800 ft. deep by the Calumet & Arizona company. The shaft will be concreted throughout. It will serve the Junction and Briggs workings, the former of which are 1800 ft. deep.

MIAMI. During July the Inspiration mine produced 485,000 tons of ore, in spite of day lost on July 4. A locomotive repair-shop is to be constructed on No. 6 level. Two more 10-ton H. K. Porter air-locomotives have been ordered.

RAY. The Ray Hercules shaft was down 338 ft. at the middle of July. The first level will be opened at 455 ft., the next at 1000 ft. or lower. Churn-drills are still at work. The daily output is one carload of 6% copper carbonate ore. The power-plant has been ordered. It will be at Kelvin, near the mill being designed, and includes three 1045-hp. oil engines driving three generators.

WENDEN. Globe people are developing the Wenden Copper

Co.'s property 8 miles north, and 3 miles from Cunningham pass. Prospects of the district are said to be favorable.

CALIFORNIA

COLFAX. The International Smelting & Refining Co. has acquired control of the Walker copper mine, at which a mill is being erected, for \$630,000. Considerable development is to be done under the terms, costing \$25,000. John F. Cowan of Salt Lake City is managing director of the Walker Copper Company.

COPPEROPOLIS. The Southern Pacific company is surveying a line from Milton to Copperopolis, a distance of 17 miles.

GRASS VALLEY. The Golden Center company is to add 20 stamps to its present equipment of 20. C. E. Brockington is superintendent.

The Orleans mine, adjoining the Empire, is being re-opened in charge of B. Crase.

HEROULT. The Noble Electric Steel Co. has three furnaces running, two making ferro-manganese and the other reducing nickel ore from the Grants Pass district of Oregon. There are 125 men employed.

LAWS. The Tip Top gold mine is to be re-opened by the Louisiana Consolidated Mining Co. The company has an option for \$35,000 on the adjoining property. The 10-stamp mill may be added to.

NEVADA CITY. With a capital of \$200,000, the St. Louis Consolidated Gold Mines Co. has been organized to operate in the Willow Valley district. J. T. Hennessey of Grass Valley is secretary.

PORTERVILLE. The district's shipments of magnesite in July were 175 carloads worth \$85,000.

COLORADO

SILVERTON. The July shipments from 31 producers in this district totaled 227 carloads, 118 more than a year ago.

TELLURIDE. The following reduced facsimile of a notice posted at San Miguel County mines is of interest to silver producers:

NOTICE

Effective June 1, 1916, and so long thereafter as the New York quotation for silver shall average by the month sixty-five (65) cents per ounce or more, the undersigned Companies will pay a bonus of thirty (30) cents per shift to every employee who works a full month; but failure to work a full month, if due to sickness, injury or other cause beyond the control of the employee, will not cause a forfeiture of this bonus.

A copy of this notice has been filed with the Industrial Commission, State of Colorado.

THE TOMBOY GOLD MINES COMPANY, Ltd.

By D. A. Herron, Manager.

THE TOMBOY TRAMWAY & TUNNEL COMPANY

By D. A. Herron, President

LIBERTY BELL GOLD MINING COMPANY

By Charles A. Chase, Manager

PRIMOS CHEMICAL COMPANY

By Robert Sterling, Asst. Manager

THE COLORADO-SUPERIOR MINING COMPANY

By J. H. Jasberg, President

THE WAGNER DEVELOPMENT MINING CO.

By John M. Wagner, President

THE SMUGGLER-UNION MINING COMPANY

By Bulkeley Wells, President

THE HUMBOLDT MINES COMPANY

By Bulkeley Wells, President

BOULDER. The Logan Mining & Milling Co. is to erect a 25-ton flotation plant during September. This mine, in charge of H. Lower, produces rich gold-silver ore.

IDAHO

OROGRADE. Washington people have financed the Orogrande Gold Mining Co., which has purchased the Butte-Orogrande property of 340 acres of lode and 145 acres of placer ground, with 200-ton mill, etc. A cyanide-plant is soon to be erected, the machinery is due to arrive soon. Hydro-electric power is available.

COEUR D'ALENE

MURRAY. The Golden Chest mine produces a gold-tungsten ore which is difficult to treat, but a process is to be tried, devised by the superintendent, R. T. Horn, and R. R. Goodrich of the School of Mines at Moscow. As much scheelite as possible is hand-sorted, the ore then being crushed by stamps, the gold amalgamated, and concentration done in Harz jigs, and on Wilfley and Johnson tables. To remove the manganese from the tungsten concentrate it is proposed to try magnetic separation.

NINE MILE. During the year ended June 30, 1916, the Consolidated Interstate-Callahan Mining Co.'s profit was \$3,100,491 against \$1,591,773 in 1914-15. Dividends were \$3,254,930 and \$697,597, respectively. The surplus is \$806,711, against \$1,094,862.

KANSAS

PITTSBURG. One block of furnaces has been closed by the Pittsburg Zinc Co., with more to follow if the spelter market does not improve, according to E. V. Lanyon.

MICHIGAN

THE COPPER COUNTRY

HOUGHTON. Three units of the Calumet & Hecla leaching plant at Lake Linden are in operation. Within three weeks the company's Dollar Bay smelter will have another furnace in blast, likewise at Hubbell, making five and three at each plant.

During the year ended June 30, 1916, the Wolverine Copper Mining Co. treated 388,898 tons of ore, yielding 6,541,492 lb. of refined copper, equal to 0.853% in the ore. This is less than in 1914-15, but the profit of \$735,218 was an increase of \$417,017. Dividends amounted to \$660,000, compared with \$350,600. The surplus is \$862,529.

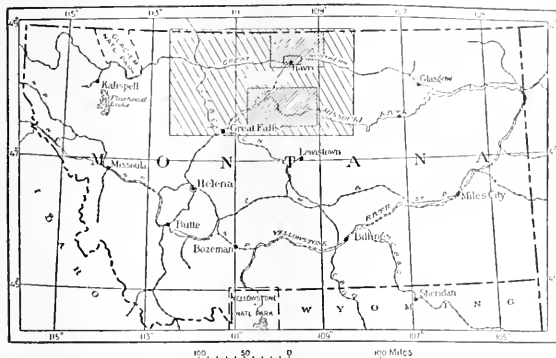
MISSOURI

JOPLIN. The *News Herald* recently published the following interesting note: Several of the assayers in this district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which an average or composite assay for the year is made. Each assay thus represents several thousand lots of ore. In most cases each individual sample included in the composite represents a carload of concentrate. In 1915, a composite made up of 1806 lots was assayed by Evans W. Buskett, and found to contain 56.76% zinc and 2.36% iron. For the same year, W. George Waring analyzed a composite of 9240 samples and found it to contain 57.19% zinc, 2.40% iron and 0.985% lead. This average sample has been assayed by W. W. Petraeus and E. W. Buskett for the last 19 years, and in that time the amount of zinc has not varied more than 1%, the average being 57%. A similar table has been kept by C. V. Millar and W. G. Waring. Their assays, however, show variations between 55.30% zinc, in 1901, and 58.95% zinc, in 1905.

The ore market at Joplin is dull and weak, blende ranging from \$50 to \$70 per ton for 60% product. The week's output was 2737 tons of blende, 122 tons of calamine, and 797 tons of lead, averaging \$59, \$10, and \$66 per ton, respectively. The total value was \$281,796.

MONTANA

In Bulletin 641-C of the U. S. Geological Survey, Eugene Stebinger discusses the possibilities of oil and gas in north-central Montana. The facts observed seem to warrant the



MAP SHOWING AREA COVERED BY OIL INVESTIGATION.

statement that considerable gas territory, on a scale comparable with the Alberta, Canada, fields, may be found and also that the area shows some probability of yielding oil. A rational search for oil and gas in the State should begin with operations in the areas where the rocks are most strongly arched.

BUTTE. The July output of the Butte & Superior was 15,000,000 lb. of zinc in concentrate, recovered from 51,710 tons of ore. This is a slight falling-off when compared with June. The new main shaft is completed and timbered to 1500 ft. It will be sunk to 1900 ft. The Black Rock shaft was damaged last week by a cage dropping for some distance.

On August 4 a serious cave-in took place at 2000 ft. in the Tramway mine of the Anaconda company.

North of the shaft at 1600 ft. the Butte & London has cut mineralized quartz. The south cross-cut is soon expected to cut the vein opened at 1100 feet.

The Tropic mine of Anaconda yielded 250 tons of $4\frac{1}{2}\%$ ore daily during July.

On the 1500-ft. level of the East Butte property a body of good-grade ore is reported to have been discovered.

Re-timbering of the Tuolumne company's Main Range shaft will be completed this month. The Colusa-Leonard shaft is in good order, as far as unwatered.

The Butte-Duluth mine and plant has been leased, by Court sanction, for 5 years to Alfred Frank of Salt Lake City. The mine must be re-opened within 15 days. The plant is to be enlarged to 500 tons' capacity.

The July pay-roll of the district approximated \$2,250,000, of which the Anaconda paid \$1,166,730, Butte & Superior, \$275,000, and North Butte, \$130,000. The wage was \$4.25 per day.

NEVADA

GOLDFIELD. At the Florence mine there is a good quantity of ore available on the 650-ft. level. The enlarged flotation plant is in operation.

VIRGINIA CITY. During July the Union Con. produced 1865 tons of ore, returning \$37,298 net. The cash surplus is now \$104,214, more than the company has had in 40 years. The Union shaft has recently been sunk from the 2000 to the 2680-ft. point, where work is held until the hot water at the bottom can be diverted by means of work that will be done through the Sierra Nevada-Union east winze. There is a working-con-

nection on the 2500-ft. level, and stations have been opened at 2400 and 2600 ft., and there will soon be one at 2300 ft. Within a few months the company expects to begin unwatering from 2700 ft. where are the lowest pumps, to 2900 ft.

Recently it was decided to explore not only the east vein of the Mexican, but also to explore the main Comstock. It was a considerable undertaking at the time as there were many thousands of feet of drifts to open up, and this work had to be done under great difficulties as to ventilation, until air connections were made. Before long will be the opportunity to explore the formation in a number of places and then the real interest will begin. Except for the ore taken out of the Union and Sierra Nevada, and a little exploratory work done in the Ophir, everything else that has been done in the last couple of years has been practically all dead-work.

NEW MEXICO

(Special Correspondence.)—Machine-drills are now in use at the Pacific mine, operated by the Socorro company, and driving is being done on the 500-ft. level. All lumber for the terminal station of the aerial wire-rope tram at mill end is now on the ground, and the ore-bins and head-frame are nearing completion. Timber for construction at the Pacific end is being delivered. No definite date has been set for placing the tram in commission, but it is understood it will be in use in the early future.

Operations for second half of July on the Last Chance mine, conducted by Mogollon Mines Co., yielded 17 bars of gold and silver bullion and 4.2 tons of high-grade concentrate. Ore treated for the period was 2125 tons. The new shaft is now some distance below the 800-ft. level, and sinking continues at rate of 2 ft. per day. The counter-balanced, self-dumping skips recently installed have relieved the congested hoisting conditions.

No. 2 orebody in the Eberle mine of the Oaks Co. has been cut south from the main shaft, and has the appearance of producing a large tonnage.

This district is credited with a total production of \$15,000,000, and is yielding at the rate of \$1,500,000 gold and silver per annum. With the consummation of larger and more centralized operations now pending, decreased mining and reduction costs that will be effected by hydro-electric power installations and more direct shipping facilities, a large tonnage of lower-grade ores will become available, and insure a greatly increased annual output for a long period. The future of the region is considered to be extremely good.

Mogollon, August 8.

OREGON

TAKILMA. At the Queen of Bronze mine a gravity train is to be constructed to the bins on the new railway partly built from Grants Pass to Crescent. The Del Norte Clans Co. of Chicago is setting-up a diamond-drill near Preston Peaks. D. Van Austrand of Denver contemplates erecting a 7000 mill, embodying flotation.—Ore shipments from mines in the Illinois valley are increasing fast. Last week 10 carloads left Waters Creek, at the terminus of the new line. Half of this quantity was copper ore from the Queen of Bronze and Waldo mines, while the remainder was chromite ore. These ores went to Tacoma and New York, respectively. A large quantity of chromite ore is said to be available.

UTAH

TINIC. Owing to lower prices of metals and the 100-day embargo on ore, wages at Tinic have been reduced 25% per shift.

At the Standard mine, a fan capable of delivering 2500 cu. ft. of air per minute is to be installed. A larger compressor

is also to be put in. Development at 1600 ft. has been satisfactory.

BINGHAM. On August 29 the Ohio Copper Mining Co.'s property is to be sold at sheriff's sale.

MARYSVILLE. The Mineral Products Co.'s mill, six miles away, has been re-modeled in charge of the president, H. F. Chappell. The revolving-kiln used to lose a lot of dust, but a dust-chamber and flues reduced this. The 100-ton mill is yielding nearly twice as much potash as formerly. The mine contains a large quantity of alunite of high grade. Near-by the Florence Mining & Milling Co. is commencing to erect a 100-ton mill.

CANADA

BRITISH COLUMBIA

TRAIL. Ore received at the Consolidated Mining company's smelter during July totaled 40,268 tons, making 286,978 tons in 7 months. The Center Star at Rossland contributed 110,177 tons; Le Roi, Rossland, 81,123; Sullivan, East Kootenai, 42,370; Le Roi No. 2, 9680; San Poil, Republic, Washington, 7928; United Copper, Chewelah, Washington, 6131; and Standard, at Silverton, 4209 tons.

Owing to better settlement terms with the Kusa Spelter Co. of Oklahoma, zinc producers of this Province will benefit considerably. As an example, V. W. Newton of the company says that in the case of a 40% ore or concentrate, with spelter at 8c., the difference in favor of the mine-owner under the new basis of settlement will be \$3 per ton.

ONTARIO

COBALT. The Coniagas company is to install a 100-ton Callow flotation plant, which has been ordered.

On August 15 the Seneca Superior paid a part liquidating dividend of 20c. per share. The total for 1916 is \$470,000, and to date \$1,577,526.

Nipissing during July produced \$288,577, from 134 tons of high and 6655 tons of low-grade ores. Development on vein 490 at No. 5 level was good. Surface dumps are now providing 90 tons of ore daily.

PORCUPINE. The Dome in July produced 38,400 tons of \$5.25 ore.

MEXICO

Shipments of mineral products into the United States during July, through Agua Prieta and Naco, were valued at \$1,182,600 and \$1,934,460, respectively. The Moctezuma at Nacozeni sent 7641 tons of concentrate, Cananea 6,515,982 lb. of copper and concentrate, and El Tigre 906 lb. of gold-silver bullion.

HIDALGO

PACHUCA. The Santa Gertrudis company reports that in June 19,775 tons of ore yielded \$154,000, of which \$16,500 was profit. The directors report that the further disturbed conditions resulting from the political tension between the governments of the United States and Mexico have militated more than heretofore against the successful operations at the mine. It became necessary during June temporarily to withdraw the American management and staff, and to arrange for the continuance of operations under English and Mexican management. A policy of future operations was arranged which necessitated the treatment of lower-grade ore than that milled during the last few months. Other causes seriously affecting profits are shortage of timber, owing to disturbed railway communications, higher cost of labor, and increased taxation.

Two fellowships of metallurgical research have been established at the UNIVERSITY of IBAHO, Moscow, by contribution from the mining men of the State. Each fellowship carries \$500. The metallurgist at the University is Robert Rhea Goodrich.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

COREY C. BRAYTON is in Montana.

E. R. RICHARDS is at Salt Lake City.

GEORGE A. LAIRD has arrived here from Sydney, Australia.

ARTHUR L. PEARSE has returned to New York from Tucson, Arizona.

K. FREITAG has opened offices in the Hobart building, San Francisco.

T. A. RICKARD sailed for Victoria, to visit British Columbia, on August 12.

CHARLES E. DUTTON of Goldfield, Nevada, has gone to New York and Boston.

O. B. PERRY passed through San Francisco on his way from New York to Dawson, Y. T.

H. C. DUDLEY, of Duluth, was in San Francisco on August 16, on his way to Lower California.

R. E. CRANSTON left San Francisco on August 11 on an extended trip through Nevada, Colorado, and Montana.

JOHN WELLINGTON FINCH of Denver has gone to China for a large exploration company. He will be gone about a year.

ARTHUR NOTMAN, geologist for the Copper Queen Consolidated, Arizona, has returned to Bisbee after a month's vacation in New York.

VAN H. MAXNING, of the U. S. Bureau of Mines, is visiting important mining centres of the West in connection with the proposed experiment stations.

HENRY M. HOWE, professor of ferrous metallurgy in Columbia University, has been appointed honorary vice-president of the Iron & Steel Institute of Great Britain.

WALDEMAR LINDGREN, professor of economic geology in the Massachusetts Institute of Technology, has received the honorary degree of Doctor of Science from Princeton University.

Among those who attended the 30th anniversary re-union of the Michigan College of Mines at Houghton last week were: **O. G. ENGELER** lately from Sardinia, **C. F. SCHABER** of Bessemer, Alabama, **ARTHUR RIGBY** of Mineville, N. Y., **ARTHUR HOULE** of Bisbee, **LEE E. IVES** of New York, **W. R. BAUDER** of Cleveland, **E. H. BRANG** of Sandow, **B. C. J. H. WINWOOD** of Salt Lake City, **GEORGE R. SHELTON** of Salt Lake City, **J. M. LONGYEAR, JR.** of Boston, **F. O. WILLIAMSON** of Chicago, **WALTER SEGSWORTH** of Toronto, and **JAMES A. BARR** of Mt. Pleasant, Tennessee.

Obituary

ROBERT SAFFORD TOWNE, well known from his connection with Mexican mines, died at the Engineers' Club, New York, on August 3, at the age of 58. He was connected with the Fresnillo, Mexican Lead, Montezuma Lead, Soubrette, Tezuatlan Copper, and the Metallurgical Engineering and Process companies.

ALVIN ROBERT KENNER was accidentally drowned on July 4 while bathing in a small lake in a public park near Nevada City, California, to which place he had recently gone to inspect the Big Murchie mine before it was to be taken over by the Rio Plata Mining Co. He graduated from the Colorado School of Mines in 1907, after a thorough training at the Armour Technical Institute of Chicago. At Chloride, Arizona, he will be remembered by the many friends that he made while superintendent of a mine at that place. During the early days of the first Villa revolution in Mexico he was superintendent of a large mine at Parral, where he stayed until the Mexicans destroyed the railroad over which the mine shipped its ore to the smelter and the property closed.

THE METAL MARKET

METAL PRICES

San Francisco, August 15.

Antimony, cents per pound.....	10
Electrolytic copper, cents per pound.....	28.75
Pig lead, cents per pound.....	6.25-7.25
Platinum: soft and hard metal, per ounce.....	\$60-65
Quicksilver: per flask of 75 lb.....	\$74
Spelter, cents per pound.....	11
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, August 15.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$0.60
Chrome: 40% and over, f.o.b. cars California, per ton.....	13.00-16.00
Manganese: 50% product, f.o.b. cars California, ton.....	12.00-16.00
Magnesite: crude, per ton.....	7.00-9.00
Molybdenum: 50% and over, per pound.....	0.60-1.15
Tungsten: 60% WOs, per unit.....	20.00

New York, August 9.

Antimony: Small quantities have changed hands at \$1.10 to \$1.20 per unit.

Tungsten: The situation continues uncertain. High-class material is quoted at from \$25 to \$30 per unit. Export inquiry continues to be received by dealers, and a moderate amount of business is said to have resulted.

EASTERN METAL MARKET

(By wire from New York.)

August 14.—Domestic buying of copper is reported; there is better demand for lead; spelter is firmer with better demand.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending	Aug. 1.
July 18.....	\$3.00	" 8.....75.00
" 25.....	\$0.00	" 15.....74.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....39.25	51.90	222.00	July ....37.50	55.00	\$1.20
Feb. ....39.00	60.00	235.00	Aug. ....80.00	93.75	....
Mch. ....39.00	78.00	219.00	Sept. ....76.25	91.00	....
Apr. ....38.90	77.50	141.60	Oct. ....53.00	92.90	....
May ....39.00	75.00	90.00	Nov. ....55.00	101.50	....
June ....38.60	90.00	74.70	Dec. ....53.10	123.00	....

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Aug. 9.....	26.50
" 10.....	26.75
" 11.....	26.75
" 12.....	26.75
" 13 Sunday	26.75
" 14.....	26.75
" 15.....	27.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....14.21	13.60	24.30	July ....13.26	19.09	25.66
Feb. ....14.46	14.33	26.62	Aug. ....12.34	17.27	....
Mch. ....14.11	14.80	26.65	Sept. ....12.02	17.69	....
Apr. ....14.19	16.64	28.02	Oct. ....11.10	17.90	....
May ....13.97	18.71	29.02	Nov. ....11.75	18.88	....
June ....13.60	19.75	27.47	Dec. ....12.75	20.67	....

July yields were: Braden, 2,760,000 lb. (low, due to bad weather); Kennecott, 10,750,000 lb.; East Butte, 1,895,120 lb.; Old Dominion, 3,852,000 lb.; Miami, 4,310,000 lb.; and Greene Cananea, 4,600,000 pounds.

Discussing copper recently, Joseph Clendenin, sales manager for the A. S. & R. Co., stated that the market has been cleared

of metal as never before. The large producers are now at the remainder of the year, with no or large stock piling.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Aug. 9.....	66.87
" 10.....	66.25
" 11.....	66.25
" 12.....	66.25
" 13 Sunday	66.25
" 14.....	66.62
" 15.....	66.62

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....57.58	48.85	56.76	July ....51.90	47.52	63.06
Feb. ....57.53	48.45	56.74	Aug. ....51.35	47.11	....
Mch. ....58.01	50.61	57.89	Sept. ....53.75	48.77	....
Apr. ....58.52	50.25	64.37	Oct. ....51.12	49.40	....
May ....58.21	49.37	74.27	Nov. ....49.12	51.88	....
June ....56.43	49.03	65.04	Dec. ....49.27	55.34	....

The inclination of prices has been upward, with periods of steadiness. The Indian Bazaars have been active, and the harvest promises to be good. China sold on recent rises. The advance in price of money in London has unsettled China exchange, and it is possible that this will adversely affect the silver market. Stocks in Shanghai on July 15 consisted of 30,500,000 oz. in silver and \$17,000,000 in other forms.

Exports of silver from San Francisco to the Orient on August 12 totaled \$700,000, say, 1,060,000 ounces.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Aug. 9.....	5.95
" 10.....	5.95
" 11.....	5.95
" 12.....	5.95
" 13 Sunday	5.95
" 14.....	5.95
" 15.....	5.95

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....4.11	3.73	5.95	July ....3.80	5.59	6.40
Feb. ....4.02	3.83	6.23	Aug. ....3.86	4.67	....
Mch. ....3.94	4.04	7.26	Sept. ....3.82	4.62	....
Apr. ....3.86	4.21	7.70	Oct. ....3.60	4.62	....
May ....3.90	4.24	8.38	Nov. ....3.68	5.15	....
June ....3.90	5.75	6.88	Dec. ....3.80	5.34	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Aug. 9.....	8.37
" 10.....	8.50
" 11.....	8.50
" 12.....	8.50
" 13 Sunday	8.50
" 14.....	8.60
" 15.....	8.75

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....5.34	6.30	18.21	July ....4.75	20.54	9.90
Feb. ....5.22	9.05	19.99	Aug. ....4.75	14.17	....
Mch. ....5.12	8.40	18.40	Sept. ....5.16	14.14	....
Apr. ....4.98	9.78	18.62	Oct. ....4.75	14.03	....
May ....4.91	17.03	16.01	Nov. ....5.01	17.20	....
June ....4.84	22.20	12.85	Dec. ....5.40	16.75	....

TIN

Prices in New York, in cents per pound.

Date.	Average week ending
Aug. 9.....	37.85
" 10.....	37.23
" 11.....	37.23
" 12.....	37.23
" 13 Sunday	37.23
" 14.....	37.23
" 15.....	37.23

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan. ....37.85	34.40	41.76	July ....31.60	37.28	38.37
Feb. ....39.76	37.23	52.40	Aug. ....30.29	34.37	....
Mch. ....38.10	48.76	50.50	Sept. ....33.10	33.12	....
Apr. ....36.10	48.25	51.49	Oct. ....30.40	33.00	....
May ....33.29	39.28	49.10	Nov. ....33.51	39.50	....
June ....30.72	40.26	42.07	Dec. ....33.60	38.71	....

Tin is strong at 39.25 to 39.75 cents.

Eastern Metal Market

New York, August 9.

Copper again presents the best tone of any of the metals. It is far from active, but the metal in second-hands is about cleared up, and the quotations for near-by deliveries are stronger.

Zinc is lower; the market is dull and the future is uncertain. The expected cut to 6c., New York, by the principal producer of lead, came to pass, but did not bring business.

Tin is in bad shape because of the excessive quantity of Banca tin on the market.

Antimony has continued to decline.

Aluminum continues firm at 58 to 60c. A decrease in imports has been a supporting factor.

The prices of many steel products have been advanced. The domestic demand is slow, but export requirements are greater than ever. Orders placed for shell-steel in the past few weeks aggregate nearly \$100,000,000, and more steel is wanted. The pig-iron market is dull and weak, likewise that for old material; which is a subject for discussion in view of the great production of finished products.

COPPER

As a result of the absorption of re-sale lots, near-by metal is scarce, and there is a tendency to ask premiums for spot delivery. The quotation for spot at this writing is about 26.50 to 26.75c. cash, New York. As a matter of fact there has been but little business in the past week, but the tone of the market is much better and prices are firm. Lake is about 26.75c. cash, New York, but nominal. October and November can be had around 25.50 to 26c., and December at 25c. There have been some export inquiries in the market, but reports differ as to whether business resulted. The trade is surprised, in view of the stiffening of the market, over the action of some of the larger rolling mills in reducing their quotation for sheet copper from 37½ to 35c. The smaller mills, while they will make the lower price to the regular customers, continue to ask 37½c. from newcomers. "Copper Gossip," published by the National Brass & Copper Tube Co., recently said the following: "The outlook for a heavy consumption of copper during the balance of the year is excellent. For a long time to come manufacturing activity is assured. Melting continues about as it has for some time, and this feature of the situation indicates an underlying soundness deserving particular consideration. The tremendous pressure put upon manufacturing capacity for many months has afforded an outlet for an enormous tonnage of copper. Unusual foreign orders kept domestic plants working night and day. Meanwhile local and domestic requirements have been held up to a large extent. But later on we look for a condition of remarkable prosperity resulting from a deluge of domestic orders. As regards copper, it is probable that with the establishment of a satisfactory price level new business in heavy volume will be attracted, especially as dilatory buyers appear to be waiting for some such action."

The London market for spot electrolytic was quoted yesterday at £124, against £125 a week previous. Exports from August 1 to 8 totaled 5966 tons. Imports (including ore, matte, and regulus) reduced to fine copper, in the first six months of the year reached the large total of 103,500 tons; total imports for the year 1915 were 127,500 tons.

ZINC

The market is lower, and the outlook is not good. Spot zinc was to be had yesterday at 8.50c., New York, and 8.25c., St. Louis. September delivery is quotable around 8c., St. Louis, and last quarter at 7.75c. The London market, at £41 for spot yesterday, is £11 lower than a week previous. Twice in the

week sizeable quantities of spelter have been sold "under the rule" on the floor of the New York Metal Exchange, which means that a few buyers have failed to take metal for which they contracted. On August 2, 75 tons of 'Granby selected' was sold for immediate shipment from the West at 8½c., St. Louis, a low price for that grade. Yesterday 50 tons of prime Western, en route from Illinois to this city, was sold on the Exchange for 8.15c. St. Louis, a price about 10 points below the market. Aside from these forced sales the market has been extremely dull. The preliminary figures on spelter production and consumption for the first six months of 1916, by C. E. Siebenthal of the U. S. Geological Survey, are variously construed. It is estimated by him that the production, etc., in that period totaled 330,922 tons, from which are taken foreign exports, 20,197 tons; domestic exports, 58,007 tons; and stocks of June 30, 24,000 tons; leaving 228,700 tons as the apparent consumption. It is pointed out that earlier in the year Mr. Siebenthal estimated the production for this year at 885,000 tons (based on available capacity), whereas the yearly rate indicated by his later figures for the first six months, is but 632,410 tons. This constitutes a bull argument. On the other hand, the figures just issued show that the stock on hand at January 1 totaled 14,253 tons, whereas on June 30 they had increased to 24,000 tons, the figures being subject to revision. In addition to the number of retorts on record June 30—193,696—there are now building or contemplated 22,188, all of which is not so favorable to the future of the metal. From August 1 to 8 exports totaled 1975 tons. Sheet zinc is unchanged at 15c. for carload lots, f.o.b. smelter, 8% off for cash.

LEAD

The expected reduction in price by the A. S. & R. Co. came late on Aug. 2, when it announced its quotations to be 6c., New York, and 5.92½c., St. Louis. Immediately after making the reduction the big producer booked two or three large export orders, but domestic consumers did not become active. Independent producers at once followed the reduction, but held at 6c., New York, for only a few hours, then dropping to 5.95c., which is about the quotation today. At St. Louis, 5.75c. can be done. It was expected that a good movement would follow the establishment of the 6c. level, but consumers continued to hold aloof from the market, evidently thinking they could buy more advantageously still. The result has been a quiet market. The London market yesterday stood at £28 15s. Exports in 8 days totaled 429 tons.

TIN

Through the week the market has been without activity worthy of note, and the one feature is the large stocks on hand, particularly of Banca tin, of which there is estimated to be 4000 tons. It sold yesterday at 36.25c., whereas spot Straits was quoted at 37.62½c. The offerings of Banca, at what is declared to be less than actual value, has upset the market. One steamer that arrived on August 4 from Batavia brought 1100 tons of Banca metal. Of Straits there is also an over-supply. A quiet market for some time to come is indicated, even though prices recede still further. Up to yesterday 1887 tons had arrived this month, and there was afloat 3285 tons.

ANTIMONY

The market has continued dull and adversely influenced by offerings of those who bought for profit, but see only losses in view. Asiatic grades were to be had easily yesterday at 11c., duty paid, and even at 10.50c., according to some reports. One or two fair-sized lots have been purchased, but in general the market presents a dead aspect. Needle antimony is nominally quoted at 8.50 cents.

EDITORIAL

T. A. RICKARD, Editor

SOURCES of flotation oils admittedly are comparatively few. We learn that the Canadian government is to investigate the possibility of utilizing pine-stumps in Northern Ontario for the manufacture of pine-oil. Flotation at Cobalt is increasing at a rapid rate, and the consumers desire to have a supply of oil near-by.

COPPER maintains a high price—27 cents. The other metals have gained strength during the week. So much copper is sold far ahead, with probable large sales in the near future, that its resistance to a decline is explainable. From the highest point during the current year to the present quotations, following are the per cent reductions in prices: aluminum, 8.9; copper, 13; lead, 29; quicksilver, 75; silver, 12; tin, 33; and zinc, 60.

SHAFT-SINKING records are always interesting. In our Butte letter this week we give some notes on Butte & Superior practice. By a combination of sinking and raising, a system increasing in popularity, an average of 250 feet per month was sunk in hard granite. The usual rate of direct sinking at Butte is 100 ft. monthly, timbering at the same time. At the Chief Consolidated mine at Tintic, Utah, a shaft 6 by 15 feet in the clear was sunk 256.3 feet in a month. For 150 feet the formation was hard porphyry, the remainder limestone. This is considered to be much above any previous record.

COAL is now being hauled from the Matanuska coal-fields to Anchorage, Alaska, over the new railroad, the first train moving on August 16. We are in complete agreement with the Secretary of the Interior when he says that "the opening of these fields is regarded as a most important valuable benefit to both Alaska and the Pacific north-west. It means cheaper fuel for that country, and it is confidently predicted that it will be followed by industrial and mining expansion." Probably in 1917 Fairbanks and other interior points will get this coal direct by rail, resulting in re-opening many promising lode mines that are now closed on account of high fuel costs.

POOR as Mexico is said to be, its trade with the United States alone for ten months of the fiscal year ended June 30, was \$119,080,000, of which \$79,023,000 was exported to this country and the remainder imported from us. This is a gain of 40% over Mexico's total trade of the previous year, which was \$88,288,000. In spite of chaotic conditions, justification remains for Humboldt's description "the treasure house of the world." Mexico

has nearly as large a population as that of Spain and almost four times its area. We note that some of the mining companies that withdrew their staffs when War with this country seemed imminent are now sending them back into Mexico, particularly in the districts distant from the northern border. Whether they are wise remains to be seen.

ARIZONA is to be host to the American Institute of Mining Engineers during the week beginning September 18. This is the first time that the Institute has met in that State. An appropriate arrangement has been made whereby smelting will be discussed at Douglas, mining and geology at Bisbee, and mining, smelting, leaching, and flotation at Globe. The papers to be read cover a diversified field. We have already abstracted some of them for this journal. Excursions will be made to the mines and reduction works of almost all the leading copper companies of Arizona, the Chino property in New Mexico, and the Roosevelt dam, the last mentioned supplying power to mines as well as irrigating the desert.

WE have received a letter from Henry R. Merton & Co., the metal merchants in London, announcing that "the shares in our company heretofore held by German firms have all been acquired by British subjects," and adding that the company's "articles of association now contain very stringent provisions by virtue of which the company is now and will always remain under exclusively British control." The objection we have expressed to the business connection between this firm, the Frankfurt Metallgesellschaft, the American Metal Company, and others, was based not upon the German control but on the fact that a small group of international or non-national brokers and dealers had the control of metal-selling in Europe and America. That objection remains.

BRITISH COLUMBIA can boast two big copper enterprises. The Britannia, on the coast, 25 miles north of Vancouver, is one of them. This mine has not yet got into full swing, and has had an undue share of bad luck recently. A disastrous snow slide in March 1915 stopped operations for three months, and a shortage of water for power during an equal period in the fall interfered seriously with production. Only 9,058,015 pounds of copper was produced in the twelve months of 1915, and on this a net profit of \$191,238 was made. The Granby Consolidated, in the Boundary district, is producing copper at the rate of 50,000,000 pounds per annum.

and in the nine months ending March 31, 1916, made a net profit of \$2,373,863. The Britannia is estimated to have 17,000,000 tons of 1.8% ore assured. The new milling units should treat 2500 tons per day, when operations are in full swing. The concentrate will be smelted by the American Smelting & Refining Co., at Tacoma, in accordance with a seven-year contract recently made.

ON another page we give abstracts of the quarterly reports issued by what are termed the "Hayden-Jackling porphyries"—the Chino, Nevada Consolidated, Ray, and Utah Copper companies. Their total yield was 109,241,946 pounds of copper; earnings, \$21,276,772; dividends, \$9,069,106; and surplus, \$12,157,664. In the previous period the figures were \$7,795,825 pounds, \$14,814,175, \$6,937,730, and \$7,650,588 respectively. These are big figures and highly satisfactory results. With copper at 27 cents and sales made far ahead, a continuance of this prosperity seems assured. Costs were reduced by all, the Nevada Consolidated showing a drop from 9.65 to 8.51 cents per pound. To treat approximately a million tons of oxidized and partly oxidized ore, a 1000-ton unit is to be erected by Chino. Additional fine-grinding machinery is to be installed at the old mill. A plant has been designed to treat several million tons of tailing. The only report giving the extraction is that of Utah Copper, which acknowledges 63.51%, a low point due to the effort to achieve a maximum production during the period of high prices for copper. We also give the Butte & Superior report.

COMPARISON is the essence of clear description; for instance, the practical value of a discussion on stoping systems depends upon the force of contrast. In this issue we publish an article elucidating the respective merits and demerits of various methods of stoping irregular masses of soft ore, as based upon experience in the Calumet & Arizona company's mines. The article is by Mr. Philip D. Wilson, assistant geologist to the company, but he gives full credit to Mr. M. W. Mitchell, a foreman in one of this group of mines, for the development of the particular methods now in use. These are various, for it has been found advisable to modify established practices so as to suit them to a diversity of local conditions. By the way, in the text as published by the American Institute we find the word 'matte' used in connection with timber and caving, to signify a protective covering; thus a "timber matte" is a covering of timber to protect broken ore from admixture with waste. Unless care is taken, this blundering use of 'matte,' noted by us in other publications, will become established. It should be 'mat,' of course. The incorrect spelling will make confusion with the metallurgical 'matte' that goes to a converter.

WYOMING is the only western state that is not important in metal mining. Comprising an area larger than Utah, and surrounded on every side by great mining regions, its mineral production is confined to oil

and coal, except for relatively small contributions of copper and gold, 175 tons of copper and 672 ounces of gold in 1915. A new industry is the mining of sulphur near Cody in the north-western part of State, not far from the Yellowstone National Park. The Midwest Sulphur Company is working open-cuts made by removing the shallow overburden of gypsum. The mixed rock underneath is said to average 35% sulphur in places where vents have allowed the sulphurous gas to escape. The rock is broken to 6-inch size, loaded in small perforated iron cars, three of which are placed in a closed retort, where steam melts the sulphur in four hours. The sulphur is drawn from the bottom of the retort, is cooled, ground, and packed in 100-lb. sacks. The refined sulphur is shipped to paper-mills, sugar-factories, druggists, and to ranchers that use it to spray crops or live-stock. The price is high at this time, being \$30 to \$35 per ton. Western sulphur has to compete with the product from Sicily, Japan, Louisiana, and Texas.

ARIZONA is the premier copper State, not only in yearly production but in number of large mines. We note that the tax commission of the State has raised the valuation of mines by \$54,705,910, of which \$19,000,000 is the increase on the Inspiration. The total valuation of Arizona's producing mines is given at \$172,731,913. The Copper Queen Company is assessed for \$36,159,300, the Inspiration for \$20,400,897, and the Ray Consolidated for \$15,568,782. The Calumet & Arizona company is assessed for \$25,248,003, which includes the New Cornelia mine at Ajo, and is second only to the Copper Queen, being more than double Miami's \$11,406,804. Among other well-known mines, the United Verde is assessed for \$20,687,011, the United Verde Extension for \$5,360,281, the Shattuck-Arizona for \$5,229,400, the Old Dominion for \$4,487,153, with the affiliated United Globe at \$4,353,936, the Arizona Copper for \$10,362,469, the Detroit for \$4,394,775, and the Shannon for \$1,020,797. In proportion to the amount of attention they have drawn, the gold mines of Mohave county seem small compared with the copper mines. The Tom Reed has the largest assessment, \$2,053,270, and the Gold Road \$318,998. The National Tungsten Co. in Pima county is assessed at \$278,500.

Mining Dividends

The prosperity of the mining industry is indicated by the large dividends paid during the first half of 1916. Contrary to what might be supposed, the Anaconda did not pay the greatest amount, but ranked below several others, including the Utah Copper. This company distributed \$8,934,695, while Anaconda paid \$6,993,750; this in spite of the fact that Anaconda is producing copper from its Butte mines at the rate of 165,000 tons per year as compared with the 100,000 tons of the Utah mine. Incidentally, Anaconda's July dividend has been postponed to August. The first place as a dividend-payer is held by a zinc-producer, the New Jersey

Zinc Company, which paid the tremendous total of \$18,200,000. Another notable zinc mine, the Butte & Superior, paid \$5,862,993 in the six months. Phelps-Dodge & Co., which is a holding company, paid \$5,400,000. Kennecott, another holding company, paid \$7,000,000; and the Guggenheim Exploration paid \$10,713,456. In Michigan, the Champion mine on the South Range exceeded the Calumet & Hecla, paying \$3,720,000 to the latter's \$3,000,000. Among other noteworthy copper-mining companies, the Calumet & Arizona paid \$2,565,676; the Miami paid \$2,054,563; the Nevada Consolidated \$2,500,000; the United Verde \$1,395,000. Among precious-metal mines, the Hollinger at Porcupine paid \$720,000 and the Dome \$400,000. The Homestake paid \$979,524; Kerr Lake, \$300,000; Nipissing, \$600,000; the North Star, \$100,000; Santa Gertrudis, a Mexican mine paid \$364,500; Seneca Superior, which has completed its career, paid \$335,219; Tonopah Belmont, \$562,500; Tonopah Mining Company, \$300,000; Tough Oakes, \$132,875; Yukon Gold, \$525,000. In the Coeur d'Alene, the Hercules Mining Company surpassed the Bunker Hill & Sullivan, paying \$1,450,000, which exceeds its issued capital, to \$827,500 of the Bunker Hill company, while the Interstate-Callahan, a zinc mine in the same region, paid \$1,394,970. A Californian quicksilver operator, the New Idria, paid \$200,000, which is 40% on its issued capital of \$500,000. The International Nickel Corporation had a prosperous half-year, paying \$5,705,876. Among the less fortunate companies is Goldfield Consolidated, which paid \$300,000 in 1915 but is temporarily off the list. So also the Tennessee Copper Company passed its regular July dividend, as did also Utah Consolidated. The Engels Copper Company, on the other hand, paid an initial dividend of $1\frac{1}{2}$ cents. All told, 1915 will be much surpassed by 1916, as the dividends for the first six months already exceed those for the entire previous year.

Labor Unrest

Labor troubles are more acute this season than usual. Great uneasiness is felt throughout the United States at the deadlock now existing between the railroads and four sections of their employees. The trainbands are demanding an eight-hour day with certain excess pay for overtime. These demands, according to the managements, are practically impossible to grant, but they have offered arbitration, which the employees have declined. The President has taken a hand in the fray and has called a series of conferences at Washington between the parties involved. At present writing practically nothing has been accomplished, both sides apparently remaining firm in their original positions. In case of a strike, the onus will be clearly upon the train-men, who, by reason of their refusal to arbitrate their differences, are arrogating to themselves an arbitrary power that will bring down upon them the full weight of popular condemnation. While it is undoubtedly true that, during the present high tide of industrial

prosperity, the railroad net earnings have been large, the lean years that have gone before should not be forgotten, nor should a possibility of further lean years be overlooked. It is to be hoped that a reasonable middle ground will be found, whereby some profit-sharing plan will be developed and this constant agitation be avoided. Copper-mining companies employ a wage-scale that fluctuates with the price of copper. Why not apply this principle to railroad operation, adopting a minimum as a basis, and a bonus depending upon the net earnings? The tie-up of the transportation facilities of this country would paralyze all industries. We hope that the President will justify his tenure of the highest office by averting so great a disaster. Mining would be greatly affected by an interruption to traffic, as this industry supplies 55% of the total of over a billion tons of freight hauled annually, and contributes 37% of the railroads' earnings. We note in a recent report of the American Railway Association that the net surplus of freight-cars on August 1 was 10,616, compared with 264,243 a year ago, showing greatly improved business of the railroads of the country.

The Treadwell Consolidation

On another page we publish an abstract from the report, just completed, on the consolidation of the three companies operating on Douglas island, Alaska. We have reproduced the larger part of the report because we know that it will be found interesting on account of its subject and the reputation of the engineers by whom it is signed. Indeed, the shareholders are to be congratulated in obtaining such good advice. Mr. H. C. Perkins, as an associate of Hamilton Smith, visited the Treadwell mine in 1889 and since then has had a world-wide experience. Mr. Hennen Jennings had been engineer to the largest gold-mining operations in the world, on the Rand, and, like his senior colleague, has won a reputation for sincerity and sagacity that is unequalled. Mr. F. W. Bradley has been 16 years in the service of the three Treadwell companies as engineer and managing director, although his official title is president; he has also been in charge of other big mines in the West and is regarded as a man whose ability matches his probity. Therefore the report is a valuable document. It deals with a serious problem; nothing less than the choice between abandoning vertical development or spending further capital in deeper exploration. The Treadwell mines have been doing poorly during the last three years, particularly the parent property. While so many million tons of ore have been blocked-out, the bottom levels are so poor that the proportion sent from the lower workings since 1912 has ranged only $1\frac{1}{2}$ % of the total mill-supply. It will be noted that the Mexican and Alaska United companies have been operated at a loss during the first five months of the current year, and we understand that 390 stamps, out of 960 on the three properties, had stopped dropping on August 1. The yield of the parent mine has declined from \$2.60 in 1914

to \$1.66 in 1916. Meanwhile the cost has risen from \$1.08 to \$1.32 per ton. Moreover the caved condition of portions of this group of mines threatens the loss of a considerable part of the ore reserves. It will be noticed that while the total of ore blocked-out is placed at over 15,000,000 tons, only 7,000,000 is considered by Mr. R. G. Wayland, the general superintendent, as reasonably sure of salvage. A big crack has been made through the main ore-bearing ground, endangering the availability of large blocks and compelling great care in the further extraction of ore. Therefore the committee of appraisal faced the most serious problem that confronts the engineer of mines: to go deeper or to quit. The reply to the question has been answered firmly and we believe sagaciously. The history of this group of mines, and the splendid production made by them, forbids a hasty abandonment of hope; on the contrary, the facts "make it imperative that all these mines should be explored and proved most exhaustively in depth," so says the report. But, in order to do this economically it is necessary that the three companies be consolidated, join forces, and unite in a comprehensive scheme of exploration, the result of which will accrue to the benefit of the consolidated property.

A Glimpse of South Africa

It is a great pleasure to us to publish, as it will be to our subscribers to read, the article on South Africa by Mr. H. Foster Bain, who is now editor of *The Mining Magazine* in London. Mr. Bain has just returned from a comprehensive journey of observation in South Africa, his travels having included not only the Cape Colony and the Transvaal, but also Rhodesia and the adjacent part of the Congo territory. Writing as an American, and transmitting to us the impressions formed during his first acquaintance with regions peculiarly interesting to mining men, he dwells chiefly on the human side of the mining industry. In the easy and agreeable style familiar to our readers he gives them vivid glimpses of the contact between the white man and the dark races of the interior, of the impact between our complex civilization and the simple ways of living characteristic of the indigenous population. But before he warns to his subject, we are given some necessary information concerning the political geography of what was formerly the Dark Continent of the days when Livingstone and Stanley stalked across our school-boy maps and blazed the trail of later knowledge. What most of us do not know about Africa is well worth knowing, and we venture to digress a moment to say that the War has exposed vast lacunae of misinformation in regard to continental areas even nearer home than Africa. Our State universities would further the education of youth—and even of our adult population—by establishing chairs of political geography, so that the average man might acquire an intelligent interest in the bigger world outside our borders. That is one reason why Mr. Bain's cheery effort to enlighten us will be keenly appreciated. We

like the emphasis on the home-like features of the country. The great gift of the miner to man has been not so much the production of metals as the opening up of new tracts suitable for the building of human nests, of places in which to work and to live, fresh opportunity and a new home. To the traveler the discovery that a name on the map is a human habitation is a surprise that no repetition can stale. By the time a man has been to a few corners of the earth and come back from them with recollections of homes and children, manly effort and womanly kindness, he begins to realize what the world is and how small a part of it his own bailiwick forms. That is the idea conveyed in a charming manner by Mr. Bain. He finds one part of South Africa not so unlike California, another recalls Colorado, a third suggests the uplands of southern Missouri. The chief difference is in the human element: the dominant factor is a large supply of cheap black labor. The economic value of the Kaffir is obvious, but, as Mr. Bain suggests, the general dependence of the white man upon the native for all manual labor is injurious to the moral fibre of the superior race. In one of his books H. G. Wells suggests that no man should go about with the marks of another man's toil on his person, for instance, a shoe-shine. To the author of 'Tono Bangay' the mansion that can boast three butlers is an absurdity. Undoubtedly the multitudinous retainers of an ancient civilization in Europe and the mob of black boys at the call of a mine manager in Africa are equally suggestive of a waste of labor, that is, the employment of men in unproductive tasks. Such conditions react on the employer, rendering him slothful and eventually ineffective. Mr. Bain's remarks on the inefficiency of both the white and the black labor on the Rand and in Rhodesia are most interesting. He explains some of the reasons for the unsatisfactory conditions. The over-supply of Kaffirs and the squandering of this economic resource is described in moderated language but none the less vividly by our observant friend. Here surely is something to which the Union Government should give serious attention, for South Africa is wasting its patrimony. Next Mr. Bain touches upon the racial problems arising from the relation of the horde of black natives to the small white communities, the relation of the Dutch to the British, and the more recent difficulties made by the East Indians, whose incursion into Natal reminds him of the trouble caused by the Japanese in California. There, as here, the conflict of races is not only a political but an economic factor that must be taken into account by those engaged in business. However, Mr. Bain concludes on a note of friendly optimism and tells the adventurous that South Africa is a land rich in opportunity, as in sunshine, Kaffirs, and menagerie beasts. We feel assured that those who read Mr. Bain's article will have glimpsed a fascinating land and that they will join us in the hope that the gastro-nomic items mentioned by him, incidentally, will have had a beneficent effect on his health, for the readers of this paper, we know, wish him good health and happiness always.

An American's Impressions of South Africa

By H. Foster Bain

He is a most unusual visitor who does not land at Capetown with his head full of misinformation about Africa. Despite well-meaning efforts on the part of fellow-passengers, the handicap of past reading is not to be overcome even in the 17 days' voyage from London. Most of us began our studies of Africa by the aid of those thin flat books of generous width of page upon which we were wont to stack our readers and arithmetics when the inevitable day came that 'school took up again.' In such books Africa was a large blotch of variegated color. Within its limits a few lakes were placed, though well toward the centre and fairly secure from accurate observation. Over its surface a few rivers found their uncertain way, and Cairo, Timbuctoo, and Capetown were given equal and impartial prominence. Political boundaries were almost as indefinitely traced as the rivers, and there are geographies still in use in which the South African republic maintains its independence, for a fact must be mature indeed to find its way into some text-books. On this meagre foundation we added a reading of Rider Haggard and Stanley, both informing and stimulating but neither exactly descriptive of Africa as it exists today. Perhaps, too, our youthful impressions were colored by the tales of some returned—I almost said 'reformed'—missionary, who dilated upon the trials and tribulations of work among the 'heathen' in 'the heart of the great black continent.' How often that resounding phrase has been made to do duty. Almost certainly our imaginations were fired by the tales of the big-game hunter, who artfully leads one to infer that from the Cape to Cairo is one unending Hagenbeck domain, mims the bars and keepers. One comes to associate 'elephant guns'—whatever they may be—with Africa as closely as bread with butter, and finally reaches a mental state when it is almost as unthinkable to start for that country without fire-arms as to attempt a ramble through rural England without a walking-stick.

It is on such a background that most of us have projected our later information about Africa. The period of company reports ushered in by the coming of the Rand, gave, it is true, a deluge of facts but without any adequate increase in information. Even when our data are correct they are more apt than not to be wrongly assembled and correlated. To one who has never been on the Rand, 'Randfontein' and 'Reitfontein' sound much alike, and unless he reads with always a map before him, which few are careful to do, facts get curiously tied up with the wrong property. Several thousand miles away it is difficult to realize that two properties which sound so much alike lie really as far apart as Cripple Creek and Colorado Springs, and that while of the same general

type, they are as unlike as the Dome mine is from that at Kirkland Lake. The resemblances between Sheba and Shamva have also misled many a careless reader who knows nothing at first-hand of distances in Africa. It is worth while to journey from London to South Africa and back if only to become mentally oriented in such matters; it is much more worth while for any mining man who has a broad interest in his profession and a keen human interest in the problems of a growing democracy. His visit will be one continuous series of stimulating experiences, and a not inconsiderable part of his time will be devoted to being set right as to things he had got wrong.

It is a trait of human nature to dwell on the unusual. It has been largely owing to this that progress has been made, for it has been by picking out the exceptional and so devising as to make it the ordinary, that better conditions have been made general. Commendable as this is, there are limits to the usefulness of the process. Most of those who have written of Africa have devoted major time and space to the things which in actual life in that country are really out of the ordinary. Lions and cannibals have been the stock properties of the writers. One may freely admit that to him who goes venturing, adventures fall, but, armed with a vivid imagination and a Cook's ticket, one may experience thrills in any land. An experiencing nature has experiences, while the ordinary citizen lives an ordinary life, in Africa as in Britain or America, and the bulk of the men and women one meets are ordinary citizens. I should not argue strongly from the limited experience of a short trip but, traveling over 8000 miles in Africa by all sorts of conveyances, and over high, low, and middle veldt, I never saw or heard a lion. This might not mean much, since I certainly was near them at times, but repeatedly friends of twenty years of more varied experience in the country assured me that their only sight of lions had been at the Zoo in Regent's Park. As for cannibals, one needs only to see the native's devotion to 'mealies' to feel confident that whatever may have been true in the past 'long pig' is by no means now a regular article of diet. Indeed the strongest and most lasting impression brought back from South Africa is of its likeness to other countries, and its entire liveableness. It is a country of homes—a country where men and women just such as you and I and our wives have their homesteads or bungalows, where children are born, grow up, go to school, and become in time men and women, with never a thought that they are temporary exiles from some more favored country. The South African loves his country and is proud of it, with a jealous and well justified pride. He resents it being considered one of the ends of the earth

where one may go to amass a fortune, but where no one not obliged to do so would think of remaining, and to one who has lived in other pioneer countries and comes by his liking for them naturally, this feeling seems the only possible one. It is only city dwellers who would be lost in any country, or those hopelessly untransplantable people to whom no place is ever like the old one, who find Africa unthinkable as a home. To a man with any ordinary degree of adaptability or any usual ability to assimilate, the new country offers a bewildering variety of stimuli and impressions out of which to build a life that can never stagnate.

It is an old saying that every farmer thinks life would be easy if he only had a gold mine, while every gold-miner looks forward to spending his declining years on a farm where, either with pigs and alfalfa, chickens or oranges, he has nothing to do but eat, sleep, and rest from his exertions, while nature provides. California has an enviable reputation among mining-men as the fairyland to which all good engineers are translated in this life whatever may be their chances in the life to come, but as I visited the Cape and drove from sea-point to Hout Bay, over to Muizenberg, and back along the high road to the Mt. Nelson hotel, I wondered whether California has not an unsuspected rival. There is the same panorama of sea, mountain, and sky, the same bewildering variety of flowers, the same beautiful smooth roads shaded by long rows of tall trees which meet in an archway overhead, and the same series of charming little houses interspersed with the more pretentious places of those of greater wealth. For the Mexican missions, the old Dutch homesteads afford a substitute, and for the Chinese and Japanese, there are the East Indians and the 'colored people' in every shade and hue, as well as in every color and cut of garment. Life must be interesting when there is so much of contrast and comfort and, on extending my journey to other old settled parts of the Cape, the conviction grew that here is a place in which a man might settle down and take his ease in comfort. The same may be said of many other parts of the country. Johannesburg is much such a city as Denver; and Bulawayo, with its wide wind-swept streets and constant talk of cattle, is reminiscent of Cheyenne. The Katanga is to most people a far-off country of hard living conditions where amid 'geological nightmares' a few pig-headed people are attempting with no skill and little information to make copper. Actually, it is a replica of the Ozark country in which the wealthy citizens of St. Louis and other knowing ones have built summer houses. The geology proves to be unusual only in the great size and richness of the orchidies, and the supposed pig-headed ones are well-trained engineers who are conducting highly-skilled technical operations under conditions that are a bit trying for the present, it is true, but which they are meeting with eminent success. Riding in a comfortable automobile to a tennis tournament, or sipping tea with your hostess in a big comfortable living-room, it seems a minor matter that a leopard last night carried off the pet dog of the assistant-manager from before his very

eyes. Such things do happen, but they do not interfere with the general smooth and even course of a pleasant existence. It is this general liveableness and likeableness of the country that one must get fixed in the background of his mind if he would correct the false impressions of the past.

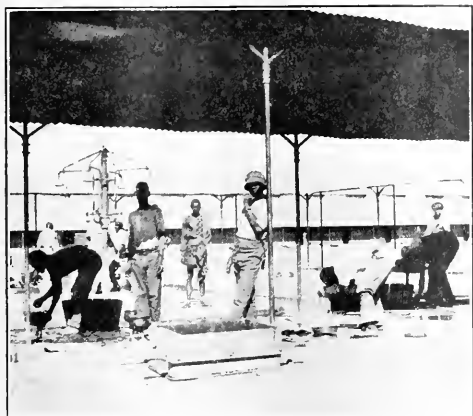
The second point that is quickly borne in on the visitor is that the average standard of comfort in South Africa is high, at least around the mines. In current phrase they 'do themselves well.' It is not merely that in Johannesburg even the shift-bosses have high-powered autos and the miners are the chief supporters of racing, but the average scale of white man's living is much above that in England and most parts of America, as proved by the figures of the Economic Commission. The houses, it is true, are small and simple, for building-materials are expensive. They are neither so large as in England nor so convenient as in America, but they are sufficient for an out-door country and they are surprisingly comfortable. Even a galvanized iron tank with a thatched roof and a cement floor makes over into a delightful room, one well adapted to the special conditions of the country. Food is varied and abundant. For a while at least I got away from the steady succession of boiled cabbage and potatoes that marks the too common limit of incursions into the vegetable kingdom in England in war-time. In South Africa peas and other vegetables are regarded as articles of food and despite the fact that 'mealies' (the local name for corn) is regarded as Kaffir food, I did at rare intervals taste roasted ears. All this wandering into untravelled gastronomic fields is possible, too, without getting out of reach of the roast beef which binds the Empire together or missing the bacon and eggs on which the sun never sets. South Africa does not yet raise all the food it requires, but, enjoying as it does a large income, it imports liberally anything lacking and even the most persistent of thin men visiting the country takes on flesh and fills out his gaunt frame.

The secret of comfort in South Africa, as also the heart of many other things peculiar to the land, is the presence of enormous numbers of black men. Untrained and ignorant of our ways as they are, they are so numerous that none are too poor to have at least one servant, and in most homes the head of the house is surrounded, like a chief of old, by a very cloud of men at hand to do his bidding. 'Let the boy do it' is about the first phrase in South Africa that a visitor hears, and 'the boy' is so numerous, so patient, and so willing, that the white man soon gets out of the way of doing anything that requires mere labor. 'The white man,' the boy says, 'works with his finger,' meaning thereby that he points out merely what some other person must do. While this does not tell the whole story, it still is largely true and in South Africa white men achieve comfort with less hard labor than in any country that I know. This mere physical comfort of living is the second point that impresses the visitor after he overcomes the first feeling of repugnance to having everything done for him. It may all be very wrong and demoralizing to both white

and black, and it may, nay probably does, involve much putting up with things poorly done, but it certainly is comfortable.

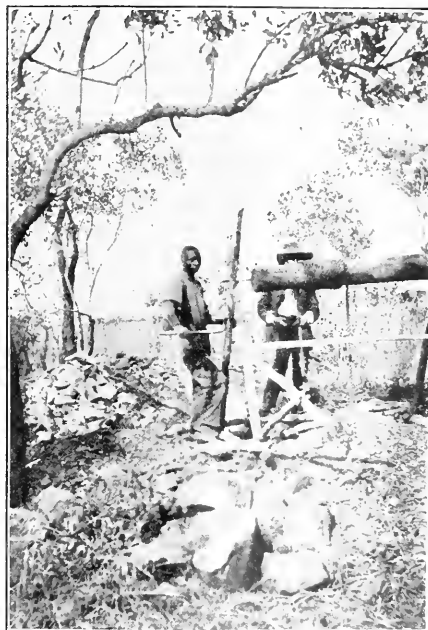
This abundance of personal service brings to mind the third impression, and it is not so pleasant. It is that of the waste in labor. Everywhere I heard of the scarcity of labor, everywhere I saw the waste and inefficiency of that which was employed. There is some attempt to economize in the number of white workers, though even here strong white men are employed to do what would be black man's work elsewhere or at least the work of boys, but there is not sufficient effort to see that the white man is efficiently used. His time is wasted and he is allowed to become slothful, waiting while 'the boy' does something he could do more quickly himself. The inefficiency of the white labor of South Africa is something

black into bad habits. Repeatedly on entering a stope the manager, mine captain, or whoever was guide, sent his personal black attendant around to stop all the machines so that conversation might be more easily conducted. If the conversation proved long and we all sat round and discussed matters to a conclusion, all the machines stood idle and the boys waited. It was a courtesy to the visitor and I would not want to seem ungrateful, but it did interrupt the work, and it at least seemed to be customary. There is not the drive to the work to which one is accustomed elsewhere and a readiness to accept excuses exists that seems appalling. It must be realized that working with raw savages many of whom



IN A NATIVE COMPOUND.

that must strike every visitor familiar with what white men can and do accomplish elsewhere. Even more appalling is the waste of black labor. Here it is not only that it is insufficiently trained, and for that there are many excellent reasons, but very little effort is made to economize in the number of boys used. At the time of my visit conditions were a trifle exceptional in that poor crops had driven an unusual number of boys to the mines and, the diamond mines being closed except for surface work, the gold mines had more than their normal complement. It is one of the anomalies of the situation that practically a mine manager must find work for all the boys applying; otherwise the flow of new boys being checked, the mine will suffer later. Therefore, work was being made for boys on all sides. And in other parts of the country and in other industries where different conditions obtained, the same over-abundance of labor was to be observed. I do not remember to have seen an underground station where there were not several black boys waiting, and repeatedly it could be noticed that when a task was finished no provision had been made in advance for moving the men at once to something else. This abundance of 'boys' leads white men as well as



PROSPECTING IN RHODESIA.

never saw a white man five years before and almost none of whom have any comprehension of, or interest in, his task, is a different matter from directing highly skilled white labor. It is also true that when the average term of black man's service is eight months, and a discouraging number of white miners drift along the 'reef' looking for a 'snap' and working but a month at a time in one property, it is almost impossible to build up a real organization, still it seems not unfair to say that too many merely take the easy way and pile more 'boys' on the work, thereby helping to perpetuate bad conditions and ruining natives who might become good workmen. This unsatisfactory condition of the labor situation is one of the phases of work in South Africa that is forced over and over upon one's attention.

Race problems are the outstanding feature of South African life. To one who has always lived in a country

where one may go to amass a fortune, but where no one not obliged to do so would think of remaining, and to one who has lived in other pioneer countries and comes by his liking for them naturally, this feeling seems the only possible one. It is only city dwellers who would be lost in any country, or those hopelessly untransplantable people to whom no place is ever like the old one, who find Africa unthinkable as a home. To a man with any ordinary degree of adaptability or any usual ability to assimilate, the new country offers a bewildering variety of stimuli and impressions out of which to build a life that can never stagnate.

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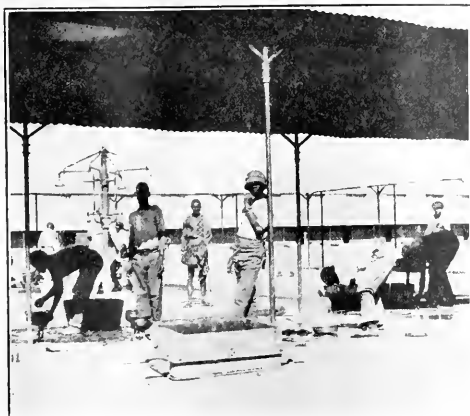
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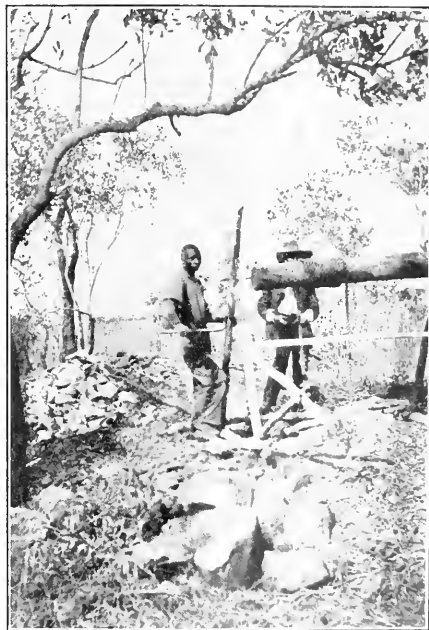
This abundance of personal service brings to mind the third impression, and it is not so pleasant. It is that of the waste in labor. Everywhere I heard of the scarcity of labor, everywhere I saw the waste and inefficiency of that which was employed. There is some attempt to economize in the number of white workers, though even here strong white men are employed to do what would be black man's work elsewhere or at least the work of boys, but there is not sufficient effort to see that the white man is efficiently used. His time is wasted and he is allowed to become slothful, waiting while 'the boy' does something he could do more quickly himself. The inefficiency of the white labor of South Africa is something

black into bad habits. Repeatedly on entering a stope the manager, mine captain, or whoever was guide, sent his personal black attendant around to stop all the machines so that conversation might be more easily conducted. If the conversation proved long and we all sat round and discussed matters to a conclusion, all the machines stood idle and the boys waited. It was a courtesy to the visitor and I would not want to seem ungrateful, but it did interrupt the work, and it at least seemed to be customary. There is not the drive to the work to which one is accustomed elsewhere and a readiness to accept excuses exists that seems appalling. It must be realized that working with raw savages many of whom



IN A NATIVE COMPOUND.

that must strike every visitor familiar with what white men can and do accomplish elsewhere. Even more appalling is the waste of black labor. Here it is not only that it is insufficiently trained, and for that there are many excellent reasons, but very little effort is made to economize in the number of boys used. At the time of my visit conditions were a trifle exceptional in that poor crops had driven an unusual number of boys to the mines and, the diamond mines being closed except for surface work, the gold mines had more than their normal complement. It is one of the anomalies of the situation that practically a mine manager must find work for all the boys applying; otherwise the flow of new boys being checked, the mine will suffer later. Therefore, work was being made for boys on all sides. And in other parts of the country and in other industries where different conditions obtained, the same over-abundance of labor was to be observed. I do not remember to have seen an underground station where there were not several black boys waiting, and repeatedly it could be noticed that when a task was finished no provision had been made in advance for moving the men at once to something else. This abundance of 'boys' leads white men as well as



PROSPECTING IN RHODESIA

never saw a white man five years before and almost none of whom have any comprehension of, or interest in, his task, is a different matter from directing highly skilled white labor. It is also true that when the average term of black man's service is eight months, and a discouraging number of white miners drift along the 'reef' looking for a 'snap' and working but a month at a time in one property, it is almost impossible to build up a real organization, still it seems not unfair to say that too many merely take the easy way and pile more 'boys' on the work, thereby helping to perpetuate bad conditions and mining natives who might become good workmen. This unsatisfactory condition of the labor situation is one of the phases of work in South Africa that is forced over and over upon one's attention.

Race problems are the outstanding feature of South African life. To one who has always lived in a country

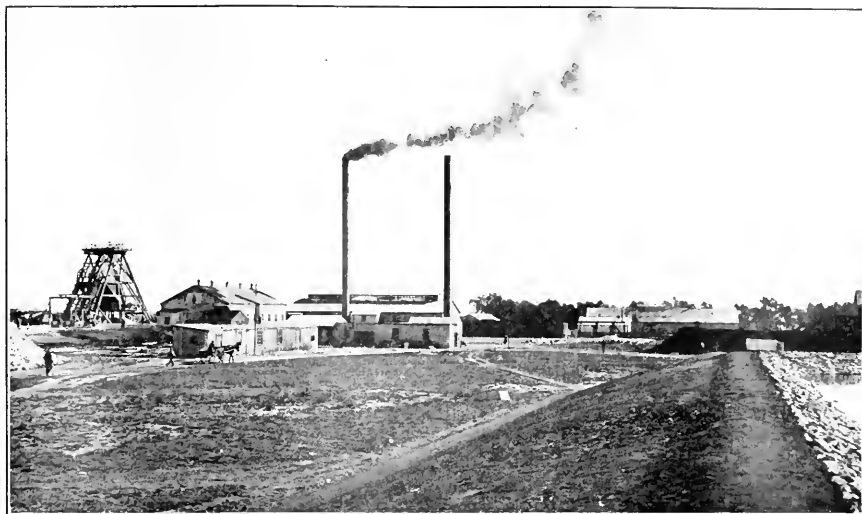
where your fellow-citizens, if they do not agree with you—and generally they don't—at least think by the same general processes, are influenced by the same ideals, and actuated by the same general purposes as yourself, South African life is a puzzle. Having always thought in certain ways yourself and lived with people who accepted most of your own premises, it comes as a shock that there are people in the world, and in numbers sufficient to make it necessary to take them into account, who, if they do not actually deny that two and two make four, at least have no knowledge of, or interest in, any number above four. To the Canadian, with his experience in fitting government to people of both French and British descent, the Dutch-British problem is an old one. The French of Canada have their affiliations with the France of long ago and have fitted themselves to their environment, just as the Dutch of South Africa hark back to a Holland that has disappeared and have been moulded by their life into a different people from the modern Hollanders. To the American with his experience with Indians under tribal conditions and with negroes in the Southern States, the white-black problems of South Africa seem all part of his past existence. But no people other than those of South Africa have been called upon to face at one time the race problems that are so disturbing features of life in both Canada and the United States. Added to this is the fact that, while in Canada the French are in the minority, in South Africa the Dutch have a clear majority. In the United States, while the total number of black men is about the same as in South Africa south of the Zambesi, they are only as 1:10 in total population and about 2:1 in the States where most numerous, while in South Africa they vastly outnumber the whites. Just as on the western coast of both Canada and the United States there are enough Asiatics to complicate the situation, so in Natal and elsewhere in South Africa the East Indian fellow-subjects of the Empire have come in to demand a place. A still further complication is that whereas Canada and the United States stand off somewhat alone, and the two peoples who in the main think alike are free to settle their race problems as they see fit, the British territories of South Africa are hedged in by those of Portugal and Belgium, in both of which the attitude toward natives and race admixture is markedly different from that in Rhodesia and in the Union. There has been a further complication due to the presence of the Germans, but what that may amount to in the future is beyond ken. These numerous and overpowering race problems enter into every phase of life in South Africa. One cannot go far in any direction without facing them and cannot investigate any problem, be it ever so technical, without taking them into account. They are kaleidoscopic in their phases and studying them is much the most fascinating problem in existence to any one who either lives in or visits the country.

I may say at once that I do not believe that they will be solved immediately or by any set rule. It will only be by slow steps and through long years that relations

will come to be adjusted. What the end will be can only be guessed and in the meantime those of us whose homes are outside the country, but who may have some definite interest in it, cannot do better than to stand aside and watch with the keenest and most sympathetic interest the struggles of those who face the problems on the ground. It is impossible, however, to think of South Africa without taking race problems into account, and each must form for himself a working hypothesis as to the changes likely to ensue in the next ten or twenty years, the period over which most of us plan investments. We may go wrong, doubtless we shall in large part, but we must come to some conclusion or else stay wholly outside the country. Perhaps the most powerful impression obtained in South Africa is of the necessity and importance of considering race problems when planning a business enterprise.

And lastly, are there opportunities in South Africa? That is what it all comes back to for those of us who are still outside, who have not committed ourselves as yet to the venture of money or person in the country. Without hesitation, I may answer Yes. The opportunities stare one in the face from the day of landing to the moment when the steamer backs away from the Cape-town quay and starts on the home voyage. Readers of the MINING AND SCIENTIFIC PRESS need little education as to the mining possibilities of the country, but I may suggest that it is by no means true that all the mines have been found or all those found have been developed. Money is needed at many points to start the wheels of industry in mining as well as for other ventures. I am not competent to judge as to agriculture, but certainly there are considerable areas of seemingly fertile land which are either not cultivated or are so poorly tended as to be virtually wild, and certainly such farmers as I met seemed by all outward signs to be doing quite as well as they deserved. Men as well as money, however, are needed; men of experience, ability, and ideals above the achievement of enough wealth to permit the owning of a string of race-horses. The country needs roads and road-makers in many a sense. It has its big men, but here as elsewhere there is abundant room at the top and men with creative ability are needed. To such men the country will yield large returns. Without facing the question as to whether Africa is to prove a white man's, a black man's, or a brown man's country, I may say unhesitatingly that there is room for many more white men than are now in the country, provided they be of the sort that makes pioneers. Such men will find a thinly occupied field, many natural resources lying unused, and a most friendly hospitable people to welcome them. With the wide sweep of the veldt in front, and glorious sunshine above, they can feel that here they start even in life and with a fair chance to win the race.

DIVIDENDS paid by Rand companies in the first half of 1916 amount to £3,631,795, compared with £3,845,036 in the same period of 1915. Far East Rand mines made increased distributions.



SURFACE PLANT AT THE RANDFONTEIN CENTRAL MINE.



DRIFTING IN THE HARD CL. OF THE RAND. NOTE THE MINED CREW.

Pocket-Hunting Applied to Prospecting

By John E. Platts

A method commonly used for prospecting hidden veins that do not outcrop seems to be unfamiliar to so-called 'engineer-prospectors.' This is 'rimming' with a pan as practised by the 'pocket-hunters' for gold.

Gold pockets are concentrations near the surface, or at least in the oxidized zone. They commonly occupy a small space such as a vug in a quartz stringer or in a small, partly open fissure. The gold is usually loose and free from gangue, which is likely to be clay and decomposed rock minerals mixed with oxides of iron and manganese and, in the deeper pockets, with secondary sulphides. In true pockets the proportion of gold to gangue is considerable, amounting to solid metal in extreme cases. Large placer nuggets are probably derived from such pockets. There is abundant evidence that these pockets are secondary deposits derived from near-by low-grade primary deposits. The gold-pockets are found in 'iron seams' and iron-bearing quartz veins and less often in calcite stringers. The pocket-hunter pays special attention to yellow spots or streaks in the alluvium, as these indicate a concentration of iron. Sufficient ferrous sulphate may be present to form a gold-pocket and not make a distinct coloration in the soil. Hence in a favorable-looking region or near where pockets have been found in the past, it is customary to do systematic prospecting over considerable areas regardless of the color of the ground. Ferrous sulphate is the most common precipitant of gold chloride in solution in meteoric water, the gold having been dissolved by chlorine set free by the action of oxides of manganese on soluble chlorides, this being the theory of formation.

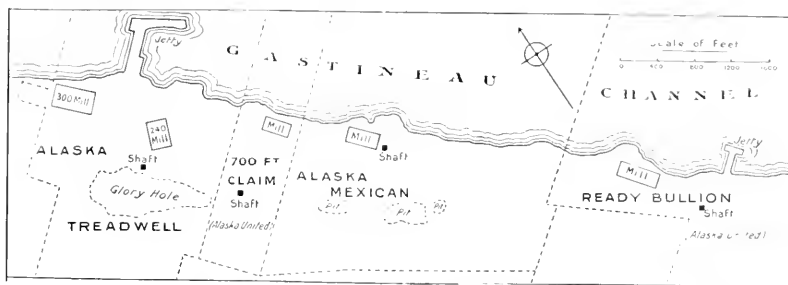
The word 'trace' is used as by pocket-hunters, meaning the spill of gold in the surface-soil. The process of sampling a trace is called 'rimming' or tracing. When the pocket-hunter finds a yellow spot on an otherwise favorable hill-side, he spades up a shovelful of earth and pans it carefully. The presence of one or two fine colors is enough to cause him to thoroughly investigate the neighborhood. He takes a row of samples along the hill-side, three or four feet apart and following a contour. If he is on a real trace several of these probably will show more or less gold, while the end-samples of the row will be barren. If a large number show gold, that is, if the trace is wide, it will mean one of three things: (1) that the pocket is some distance up the hill, (2) it is an unusually large one, and (3) the gold comes from a vein in which it is not concentrated in pockets. The first contingency is the most probable, and the third next; big pockets are rare. The pocket-hunter then takes another row of samples a short distance higher up the hill than the first row. It is not necessary this time to take the extreme end samples much beyond the limits of the trace as shown by the first row of samples. If the pocket is near by, the strip of soil carrying gold will

narrow rapidly as one goes up hill. If the trace comes from a true pocket it will contract to a width of a few feet as the prospector takes successive rows of samples. Here he must move slowly and cautiously, as the pocket may be in the surface soil and contained in a space no bigger than a shovelful. It is easy to overlook such a pocket, or unwittingly shovel it down the hill. However the pocket is usually found in the bed-rock. A point will be found where no gold appears on the surface. Deeper digging for the next row of samples will show that the trace is still there, and a careful examination reveals a layer in the soil of a different color to the rest, commonly more yellow. The gold will be confined to this yellow layer and to a narrow strip of it. At this point the experienced pocket-hunter begins to pan the entire gold-bearing streak instead of only samples, to avoid shoveling the pocket over the dump. Inexperienced pocket-hunters lose much gold by neglecting to observe this precaution. The gold-bearing layer will be found to approach bed-rock as it is followed until it lies upon it, and finally stops at an iron seam or quartz stringer or vein of calcite. After finding the vein that contains the gold, the prospector continues to dig and pan all the gold-bearing material until the pocket or pockets are unearthed. A single stringer will often contain several pockets.

If the ground is flat the surface-soil is likely to be deep, and the amount of digging below the surface will be extensive. If the hill-side is steep, the surface-soil will be thin or absent in spots, and when a trace passes over a bare spot it is difficult to follow. Surface slides often complicate traces. A close inspection of the colors with a lens will tell the experienced pocket-hunter whether a trace is worth following. True pocket gold is rough and ragged, often appearing like fragments of finely branched moss. Smooth grains like tiny seeds or flakes are likely to lead to unprofitable scattered deposits in talc or serpentine.

Pocket-hunters are sometimes embarrassed by overlapping traces, that is, traces from several sources mingled in the same soil. The expert can often untangle overlapping traces by examining the gold and noting differences in color. Natural gold from different deposits is likely to vary more or less in the color due to alloyed impurities.

The method of the pocket-hunter can be used to advantage by the man prospecting for larger gold ore-shoots. Such are likely to be found in the softer and less resistant portions of veins, and hence are often covered with surface-soil. A large deposit does not throw a narrow trace like a pocket, but a more scattered layer of finer gold. When, for any reason it is suspected that an ore-shoot may apex on a given hill-side, a systematic rimming will find it or prove its absence. This prospecting method may be applied to the search for cinnabar, tungsten minerals, and cassiterite. Where base metal sulphides appear at the surface, lead, copper, and iron sulphides may be panned from the surface soil below an apex.



PLAN OF PROPERTIES ON DOUGLAS ISLAND, ALASKA.

Consolidation of the Treadwell Mines

[Herewith we give abstracts from the report by a committee of engineers, composed of Messrs. H. C. Perkins, Hennen Jennings, and F. W. Bradley, who were called upon to advise on the consolidation of the Alaska Treadwell, Alaska United, and Alaska Mexican companies; operating contiguous mines on Douglas island, Alaska.]

THE ANNUAL REPORTS of the three companies have been carefully studied. Since 1890, these annual reports have given the most comprehensive and generous information, and as they have mirrored the successful accomplishment of gold mining upon the lowest-grade ore exploited until recent years, these reports have historic as well as present practical value. [The Ready Bullion and 700-Foot claims belong to the Alaska United company.]

The summary of returns from each mine, from the starting up to June 1, 1916, are as follows:

TREADWELL

Tons crushed	16,966,702
Total yield	\$38,803,810.85
Total yield per ton	2.41
Operating profit	17,907,530.28
Operating cost per ton	1.31
Operating profit per ton	1.10
Total dividends paid	15,785,000.00
Dividends per ton	0.99

READY BULLION

Tons crushed	3,802,209
Total yield	\$7,910,191.25
Yield per ton	2.08
Operating profit	1,966,011.57
Operating cost per ton	1.57
Operating profit per ton	0.51
Dividends per ton	0.338

700-FOOT

Tons crushed	2,239,833
Total yield	\$4,644,316.34
Yield per ton	2.07
Operating profit	1,086,288.58
Operating cost per ton	1.59
Operating profit per ton	0.48
Dividends per ton	0.339

Alaska United dividends total \$1,991,210.

MEXICAN

Tons crushed	4,355,213
Total yield	\$11,438,812.47
Yield per ton	2.62
Operating profit	4,078,748.64
Operating cost per ton	1.68
Operating profit per ton	0.94
Total dividends paid	3,507,381.00
Dividends per ton	0.81

The grand total summary of accomplishment of all the mines for the period of their whole history is as under:

Tons crushed	26,464,047
Yield	\$62,797,459.91
Yield per ton	2.37
Operating profit	25,038,579.07
Operating cost per ton	1.42
Operating profit per ton	0.95
Dividends	21,337,651.00
Dividends per ton	0.805

If the returns for the years 1914 and 1915 and the first five months of 1916 be compared, they will show as under:

	TREADWELL			Jan. 1 to June 1 1916		
	1914	1915		1916		
Total yield	\$2,367,561.71	\$1,828,723.49		\$642,900.86		
Yield per ton	2.60	2.03		1.66		
Operating profit	1,386,119.36	718,521.13		195,346.73		
Operating cost per ton	1.08	1.23		1.32		
Operating profit per ton	1.52	0.80		0.34		
	MEXICAN					
Total yield	509,023.61	379,796.82		111,308.87		
Yield per ton	2.18	1.75		1.31		
Operating profit	170,020.18	99,476.75		1,086.58*		
Operating cost per ton	1.15	1.29		1.56		
Operating profit per ton	0.73	0.46		0.22*		
	UNITED (READY BULLION)					
Total yield	531,497.68	521,912.25		253,661.85		
Yield per ton	2.29	2.07		2.09		
Operating profit	191,827.34	192,738.40		85,561.98		
Operating cost per ton	1.47	1.31		1.39		
Operating profit per ton	0.82	0.76		0.70		

UNITED (700-FOOT CLAIM)

Total yield	431,383.89	520,262.50	171,952.29
Yield per ton	1.91	1.85	1.93*
Operating profit	66,112.24	151,253.99	27,563.75*
Operating cost per ton...	1.62	1.31	1.96
Operating profit per ton.	0.29	0.54	0.27*

* Loss.

THE ORE RESERVES ARE AS FOLLOWS:

	Tons	%
Treadwell	7,012,755	44½
Mexican	1,188,866	7½
Ready Bullion	2,583,105	16
700-Foot	4,893,908	31½
Total	15,678,634	100

It will be noted that for the ore in place (which includes pillars) and also for the broken ore, no valuation is given, nor can it be given accurately, but an estimation has been made by the general superintendent, Mr. R. G. Wayland.

This valuation is really on the basis of salvage, that is, no development costs are included and all charges preparatory to future exploitation are omitted. A summary of his valuation is given and discounted to present value by 6% annuity-tables with rough estimates of the time required to extract the ore, as under:

Mine	Tons	Profit per ton	Total profit	Present value per ton	Present value
Treadwell	3,000,000	\$0.46	\$1,368,000	\$0.41	\$1,231,000
Mexican	50,000	0.30	15,000	0.30	15,000
700-Foot	2,400,000	0.28	666,000	0.25	598,000
Ready Bullion...	1,560,000	0.94	1,470,000	0.64	992,000
Total	7,010,000	\$0.50	\$3,519,000	\$0.40	\$2,836,000

The factor of caving possibilities in the future is most serious. It is thoroughly discussed by Mr. Wayland, and will be referred to later in this report.

The geological cross-section of the Ready Bullion, showing the position of the old shaft and Gastineau Channel, explains graphically the high discount given to the pillar-reserves of this mine and the reason for the abnormal proportion of ore held in reserve in pillars compared with the ore milled; but it is to be noted that a greater present value is allowed for the ore reserves in this mine than the mine has earned in dividends during its life of 18 years.

Costs. The annual reports have given, in much detail, the operating and other costs of the various departments over long and varied periods; but to make fair comparisons between periods or hazard future forecasts, more than periodical results must be known and taken into consideration.

While working stopes, mining conditions make it imperative that only one-third of the ore so broken can be drawn for the mills. Therefore in some periods of disappointing development, it is difficult to have a sufficient number of new stopes in progress to maintain a mill feed consisting of normal proportions of freshly broken ore, broken ore in reserve, and caved ore from pillars. In time of supposed plenty, if underground

conditions seem favorable, the temptation is great to reduce the accumulation of broken ore; and under other circumstances on account of lack of profitable ore to start new stopes, the amount of broken ore does not correspond with the mill demands owing to the impossibility of opening enough stopes to maintain the supply. Should shaft, general development, and stope work be allowed to get behind, such arrears must be made up in later periods, and future costs are thus adversely affected. At the present time the Treadwell, the Seven Hundred, and the Mexican mines are in the unfortunate condition of being unable to make a good showing of tonnage unless a trespass is made upon pillars and reserves of low-grade ore.

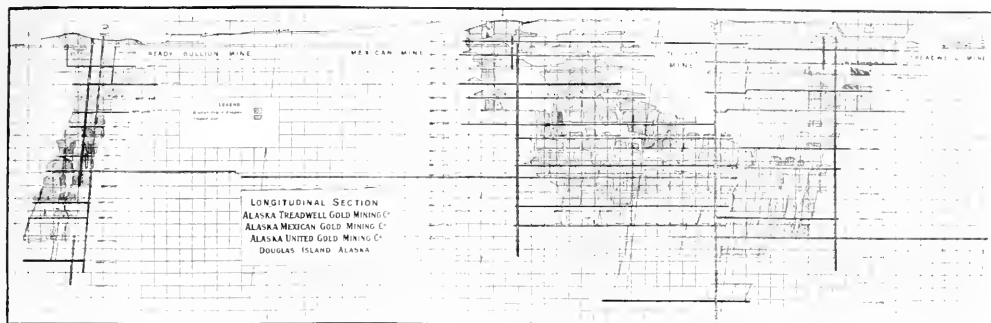
When there is a serious fall in the yield of a mine and a lower grade of ore than has been successfully worked in the past is all that is available, self-preservation prompts the making of an extra effort to reduce the working cost, even if it demands new capital outlay. This is justifiable, provided there is positive assurance of sufficient quantities of ore being available to redeem the extra expenditure incurred.

The Alaska Juneau and Alaska Gold companies, operating on the mainland opposite Douglas island, have both been able to make a showing of a much lower working cost. The Alaska Gold Mines Company has definitely set forth the possibility of reducing the total working cost to less than 70 cents per ton; but to do so this company has incurred a capital outlay amounting to some \$7,000,000. The Alaska Juneau is engaged in developing its mine on a daring but sound caving system by which it is believed even a cost lower than that claimed by the Alaska Gold Mines can be obtained; but here the mine development and mill construction work in progress demand an expenditure of \$4,000,000.

It has been our privilege to inspect the workings and plants, as well as the maps and accounts, of both of these companies. We are satisfied that they will achieve a new record for low cost in gold mining. We are also satisfied that the mining conditions presented by them are not comparable closely with those existing at Treadwell, where the rock is harder to drill and less favorably adapted to the caving method. These mines on the opposite shore are so developed that the lowest level is several hundred feet above the bottom of the mill; thus they have no costly hoisting or pumping equipments nor the cost of operating such machinery, coupled with increased temperatures due to increment in depth.

The metallurgical methods as employed at present in the Alaska Gold mill are slightly cheaper than at Treadwell, but this is off-set by the greater pro-rata loss in the tailing. The extraction at Treadwell is 89.86% as compared with 81.06% in the Alaska Gold mill.

The feasibility of lowering costs by new equipment both underground and at surface at Treadwell has been considered carefully by the consulting engineer, Mr. P. R. Bradley. He has a thorough knowledge of the Alaska Juneau—Alaska Gold practice and accomplishments, and, as manager of the Alaska Juneau, he is conversant



SECTION SHOWING UNDERGROUND WORKINGS; THE SQUARES REPRESENT 100 FEET ON A SIDE.

with the possibilities of making even a better showing for your companies. His tentative and preliminary estimate for a combination plant sets forth the following saving in operating costs:

Mining:	Per ton	
Stopping	\$0.122	
Tramming	0.032	
Hoisting	0.026	
Pumping	0.001	
		\$0.181
Milling:	Per ton	
Crushing	\$0.012	
Tramming	0.009	
Stamping	0.063	
Concentrating	0.035	
		\$0.119
		\$0.300
Concentrate expense		\$0.024
Total saving per ton		\$0.324

The capital expenditure required to obtain these savings would be \$1,356,462.

This seems to us a sanguine estimate, but it is illuminating in that it suggests the maximum reduction of working expense. The report is most able and interesting, but the expenditure involved would only be justified by the certainty of an adequate reserve of profitable ore. Since writing his report, Mr. Bradley has given closer study to other problems connected with the mines and he is now in hearty accord with us; that new mill-equipment should await more assured and better mining disclosures and in the meanwhile surface improvements be kept to a minimum. On the other hand, we agree with him in recommending a larger expenditure underground.

ACCOUNTS. Appended herewith are valuation statements of the independent surface and other equipment of each company and of the proportionate interest of each company in the joint facilities and utilities as prepared by Mr. H. A. Pinger; and also statements of the cash assets and liabilities of each company, exclusive of its properties and plants, as prepared by the Secretary, Mr. F. A. Hammersmith. These statements show that the cash assets, after deduction of liabilities, of the three companies amount to \$1,584,868. And they show the

surface equipment and joint utilities to have a valuation of \$4,745,331, the grand total being \$6,330,200. The expenditure necessary for the full equipment of the mines to their present crushing capacity of 4850 tons has amounted to practically \$1000 per ton of daily capacity.

Comparing these statements with those contained in the annual reports, the reason for the operating profit being in excess of the dividends is apparent.

ORGANIZATION. The Douglas Island mines have been managed in the past as if they had been owned by one company. The Treadwell has been the pioneer, or parent, of the group. It has played the part of banker for the other companies, and has enabled them to obtain a large amount of their equipment and facilities from operating profits. The dates of the starting of the various companies are as under:

Alaska Treadwell	1889
Alaska Mexican	1891
Alaska United	1894

The Treadwell company owns the stores, machine-shops, foundry, original water-power, original wharves, boarding-houses, etc. It has furnished and supplied the other companies with such necessities at a moderate percentage above cost.

All of the supply departments sell goods to the public in general through the store, the latter getting the benefit of the extra profit over and above the departmental percentage. The store's profits accrue from supplies sold to the public at retail. Other departments show but small profits.

The President and Board of Directors of each of the companies are the same, as are also the head officials; differences are found only in a few minor departments. The Superintendent has no motive to favor one company more than another, and, as far as we can learn, the present or past superintendents have not done so knowingly. Such an organization has much to commend it in the way of reducing the overhead charges for each company and in obtaining high-class talent for each. In time of peace and plenty, this system has certainly worked effectively and harmoniously; but, should a time of stress and disappointment come, coupled with conflicting ownerships, there exist latent explosive possi-

bilities in such a co-partnership, especially when mixed with the Schedule 'B' arrangement.

MINING PROPERTY, UNDERGROUND CONDITIONS, AND OUTLOOK. The mining properties of the three companies are contiguous and interlocked, being situated upon and covering the lode-channel containing the ore-bodies.

The Treadwell group can be considered in two sections, the eastern and western. The eastern is distinct and known as the Ready Bullion mine, which is some 2400 ft. from the nearest exploited ground of the Mexican mine. Its problems and underground conditions seem distinct, although the lode-channel in all the mines is a dike-rock of similar character that may possibly have had the same origin.

The western section consists of the Treadwell, Mexican, and Seven Hundred Foot mines. They are in such juxtaposition and so merged together and influenced by similar conditions, that they should have had one ownership; but a compromise has been made in the union of management under one general superintendent, as has been already stated.

It would appear that the Ready Bullion is a diorite pipe with varying dip, and with varying swells and contractions, but of restricted area. The condition of the bottom of the mine is most favorable; in fact, the showing there is above the average both in tonnage and assay-value.

Although the amount of ore below the 2200-ft. level in the Ready Bullion (1800-ft. level, Treadwell datum) is merely a matter of guesswork, the fact that high gold contents have been found on the United's 700-ft. claim on the 2300-ft. level (4600 ft. to the west), or 500 ft. deeper, warrants an estimate of profitable ore below the present bottom; therefore an assumption of, say, 300 ft., to the 2100-ft. level seems fair.

To obtain some base-line for the estimate of ore below, the record of the mine offers the best basis. Consulting this, it will be found that the average profit per year for 18 years has been \$104,000, but with 40% of the ore left as pillars. Allowing a proportional valuation of the pillars on the basis of Mr. Wayland's estimate and a time allowance of six years for the work, an extra credit of \$370,000 should be given to the Alaska United's present total assets.

Though the Ready Bullion mine has at present a most encouraging outlook, it has not bulked large in dividends

little more than 6% of the total for the Douglas Island mines, as shown below:

	Dividends	%
Treadwell	\$15,785,000	73.98
Mexican	3,507,381	16.43
700	760,582	3.56
Ready Bullion	1,281,688	6.03
Total	\$21,337,651	100.00

The history, returns, and ore reserves of the western mines have already been given. The output of \$54,886,968 yielding \$21,337,651 in dividends, besides most of the cost of the present equipment, is certainly a

heritage of hope, which demands at least that all reasonable mining exploration should be continued before work is abandoned in this territory.

While there have been periods of depression and uncertainty in the past, especially between the years 1900-1902, there has never been such a critical state of affairs in the history of the companies as exists at present; nor one that demands as much hopefulness, skill, and good judgment from the management as well as larger hope and patience from the shareholders.

The Mexican mine may be obliged to suspend all milling operations in a few months on account of the lack of ore, and on its present lower levels there seems but little likelihood of finding further profitable ore.

From the Treadwell, Mexican, and 700 mines, below the 1600-ft. level, the proportion of ore sent to the mill was less than 1% in 1912, less than 0.5% in 1913, less than 1½% in 1914 and less than 2½% in 1915. The stopes above the 1600-ft. level are now about exhausted and the mills are being kept running largely by drawing on the reserves. The value of the ore developed and worked in the stopes below the 1600-ft. level has, on the whole, been most disappointing. Encouragement, however, should be taken from the fact that for the Treadwell the assay-value of \$1.85 on the 2100-ft. level is 39c. higher than the average of \$1.46 on the 1750-ft. level; and that for the 700 Claim, the average of \$1.80 on the 2100-ft. level is 86c. higher than the average of 94c. at 1750 feet.

The combined area of the orebody of the Treadwell and 700 mines, on the 2100-ft. level is greater than for any other level above.

A bore-hole recently run in the centre of the orebody on the 2300-ft. level has shown, for a distance of 272 ft., an average assay-value of \$2.40 per ton—a circumstance certainly most encouraging, as it demonstrates that satisfactory ore does exist at this depth. The 2300-ft. level has been but partly developed and it will be nearly another year before its true character is determined by the usual development and stoping work.

At the present time, development work and facilities for exploitation even on the 2100-ft. and 2300-ft. levels are by no means satisfactory. The danger of settlement of the machinery connected with the Central shaft, as also the possibilities of further changes in the alignment of the shaft by settlement are shown in the appended statement of the general superintendent. Men and materials are lowered from the No. 2 shaft of the Treadwell to the 1750-ft. level and then transferred some 1500 ft. to the Central shaft. This shaft has been enlarged below this level and one compartment added, which is served by an independent electrical winding-engine underground. Should cracking or caving prevent the operation of the Central shaft, from which a daily output of about 4000 tons is being hoisted, all exploitation would have to be suspended until a new shaft and equipment could be put into operation elsewhere.

It is only recently that a decision was made providing for the safe and thorough development of deeper levels. This is to be accomplished by the enlargement of the old

main Mexican shaft, now known as the Combination shaft, which work was started in January 1916.

In Mr. Wayland's appended statements will be found an estimate of cost and a time-schedule in relation to the development and opening of the 2500-ft. and 2700-ft. levels. This estimate shows that an expenditure of \$11,115,000 will be required and that the stopes will not be ready to be drawn until January 1922, or about 5½ years from now. It would appear that conclusive evidence as to the economic value of the orebodies in depth and the influence of the Starr dike cannot be looked for short of the 2700-ft. level.

In regard to the extra cost to be incurred as depth is gained, the most obvious are in the departments of pumping and hoisting. There being but little water in the mines and as the present cost of dealing with it is but two cents per ton, there appears no necessity for anticipating any serious increase in this item.

The cost of hoisting is 10 cents per ton, but with improved facilities, a reduction rather than an increase may be expected—at least on the 2500-ft. and 2700-ft. levels—but at the price of great capital outlay.

The following observations of temperature have been taken in the Treadwell mine:

Level	°F.	Level	°F.
990	58.6*	2100	73.1
1250	59.9	2300	78.0
1600	64.7	2300	76.0*
1750	68.0		

*Records were taken too near a shaft to be correct.

These temperatures were taken during the month of March 1916. The thermometers were sealed in drill-holes (varying from three to seven feet deep), and allowed to remain until a constant reading was noted (24 to 72 hours). An increment of about 1° for every 60 ft. in depth is indicated. This is not abnormal, but much greater than is found in the deep workings of the gold mines of South Africa and the copper mines of the Lake Superior region where the increment of increase is unusually small, not over 1° for each 200 ft. in depth. However, down to 4000 or 5000 feet working conditions can be made favorable by generous ventilation, but only at the cost of large capital outlay for equipment.

The factor of increased cost due to depth on the Witwatersrand, South Africa, shows the importance of ample ventilation, the difficulties in connection with extra pressure of superincumbent strata, the great extra

capital expenditure involved, and the economies effected by the consolidation of power.

All the foregoing conditions point to the absolute necessity of vigorous work on the Combination shaft, should serious deeper development be decided upon. The maps and section show the freedom of this shaft from caving. It is true that an incline shaft on the north-western side of the mine could be made to serve the same purpose, and should the Central shaft cave at some future time and much deeper exploitation be justified by encouraging development, it might still be necessary to sink it; but the quicker and cheaper plan is to continue the Combination shaft.

The difficulties and costs incident to deeper exploitation, even down to the 2700-ft. level, have been now fully presented. The main factor above all others is the persistence of the ore. All the factors bearing upon this problem have been considered, with, as a whole, more reason for discouragement than encouragement. At the depth of 2300 ft., having in mind the past records, it would appear that the 700 mine has the best possibilities in this regard, while the Mexican has the worst and the expectations of the Treadwell are limited. A careful study of the plans and geological sections and the inspection of the mines would lead one to conclude that the present trend of the gold-bearing dikes must change in depth, as these dikes may be restricted by, or be merged with, more barren dike-matter. The dike known as the Starr would seem to have a trend to the north-west and to have been a factor in the cutting or pushing out of the gold-bearing dike in the Mexican mine. If the Starr dike continues on its present course, it will interfere with the ore in the 700 mine at the 2300-ft. or 2500-ft. level, and at about 3000 ft. it will affect all the Treadwell and 700 orebodies. Assuredly it presents a serious menace unless conditions change in depth. There is, however, no certainty that at depth more favorable conditions will not supervene, and new orebodies may be found as good as those above. There is mere conjecture, but it points to the necessity of all three companies standing together and sharing in the risk and profit, on some established basis, of the deeper and costly exploration that must be undertaken.

SUMMARY AND DISCUSSION. The various visible assets of the three companies, with an allowance of ore for the Ready Bullion below its bottom level, can be summarized and tabulated as follows:

VISIBLE ASSETS						
Company	Surface equipment	Joint utilities	Cash assets less liabilities	Present value ore-reserves	Total	%
Treadwell	\$1,364,070	\$1,386,108	\$1,198,324.52	\$1,231,000	\$5,179,503	54.3
United	638,650	462,036	147,718.22	1,960,000*	3,208,445	33.7
Mexican	432,390	462,036	238,826.12	15,000	1,148,252	12.0
Total	\$2,435,150	\$2,310,180	\$1,584,868.86	\$3,206,000	\$9,536,200	100
*700-Foot above bottom	\$598,000					
Ready Bullion above bottom	992,000					
Ready Bullion below bottom	370,000					
	\$1,960,000					

In this statement, the valuations must not be taken as a basis of share appraisal, but merely as a guide for obtaining equitable proportions for a consolidation; and under the supposition that a large amount of work will be justified in the future.

The ore reserves have been discounted to present value by estimating future profits as annuities at 6%.

The development and assay-value of the ore on the bottom levels of the various mines are such that in none of them, with the exception of the Ready Bullion, does the showing justify any definite calculation of profitable ore below. There are, however, substantial grounds for hopes of betterment, as already stated.

The Ready Bullion ore-pipe on the lowest or 2200-ft. level (corresponding to 1800-ft. Treadwell) is 500 ft. long by an average width of 116 ft. with an average assay-value of \$3.37. This assay-value and the lack of any disturbing factor justify an allowance of about \$500,000 gross profit, with \$370,000 net present value as given by Mr. Wayland, even if a somewhat speculative credit is given to the outlook in depth. Ready Bullion has therefore been credited accordingly in the tabulation of visible assets.

However, such assay-values must not be taken as a mill return without modification: the loss in tailing has to be deducted and an allowance must also be made for a variable coefficient of average divergence from mine assays. These differences have been found as follows:

	Average mine assay value per ton	Mill and cyanide returns per ton
Ready Bullion	\$2.66	\$2.08
700 Claim	2.52	2.07
Mexican	3.05	2.62
Treadwell	2.53	2.41

An effort has been made to arrive at a basis for consolidation by giving certain assets preferential consideration over other assets, such as taking cash assets, less liabilities, at 100; and taking at 50 each the joint utilities, the surface equipment, the present value of ore reserves, and our ideas of future prospects. On this basis the proportion works out thus:

Treadwell	United	Mexican
53.81%	34.20%	11.99%

CONCLUSIONS AND RECOMMENDATIONS. We have considered all the factors bearing upon the present earning capacities of the different properties, the quantity and quality of the ore reserves, the probabilities of more ore and its possible value; we have discussed the mining problems and the means of overcoming the difficulties arising from working at greater depth and the danger connected with caving ground; and we have taken into consideration the present and future equipment. Two of the members of your committee had all available reports and data before them at Washington, D. C. for several months before visiting the mines. They spent three weeks at the mines and ten days at San Francisco in investigations and deliberations. One of them, as a member of the firm of Smith & Perkins, visited Douglas

island in 1889 and brought about a change of ownership and initiated the plan of management since largely followed. The other member of the Committee has spent 16 years in the service of the companies and has an intimate knowledge of all their affairs.

The committee, with the facts, aid, and study given to the consideration of the problem, now urgently recommend a speedy consolidation of the three companies in as intimate and binding a way as possible. The legal method of working out the consolidation should be left to your able legal advisor, Judge Curtis H. Lindley.

The equitable basis for the consolidation we find to be 54% Alaska Treadwell, 34% Alaska United, and 12% Alaska Mexican.

The dominant necessity and advantage of immediate consolidation seem to us to be as under:

The arrangement of joint management without unification of boundaries or ownership has been worked with efficiency and fairness in the past, but it is not possible for this arrangement to take care of the future. In the past, the management has been able to preserve the equities and keep separate the ores of each property; this is becoming a more and more difficult problem with depth owing to the caving of pillars.

The recent development of the Treadwell, 700-Foot Claim, and Mexican mines has been disappointing, complex and interlacing; and the lower levels of these three mines as at present developed are not payable as a whole. However, the lower levels of the Ready Bullion are, as already stated, in a much more satisfactory condition.

There is no certainty that the trend of the gold-bearing dikes and of the barren dikes in the Treadwell, 700, and Mexican mines will continue in depth as at present; that is, while the orebodies show a tendency to unite in one great ore-chimney, we cannot predict its trend in depth. On the other hand, the history of the Ready Bullion, Mexican, 700, and Treadwell mines, with an output of \$62,797,459 from which \$21,337,651 in dividends has been paid, makes it imperative that all these mines should be explored and proved most exhaustively in depth.

The 2100-ft. level from the Central shaft is the lowest that has been fully developed and this has proved the existence of a great mass of low-grade ore, but only parts of it are profitable.

The 2300 ft. level from the Central shaft is only partly developed, and while the assays from development work thus far show ore that is close to the economic limit, a bore-hole run 272 ft. in the most promising part of the 700 mine gives an average assay-value of \$2.40, with several assays above \$9 per ton.

There is not sufficient certainty of the behavior of the orebodies in depth to justify any one of the companies in undertaking the burden of deeper development alone, inasmuch as it would cost over \$1,000,000 for additional equipment and exploration down to the 2700-ft. level.

The most conclusive results can be obtained most speedily and economically by seeking for more orebodies upon the lines laid down by Nature rather than upon artificial boundaries of ownership.

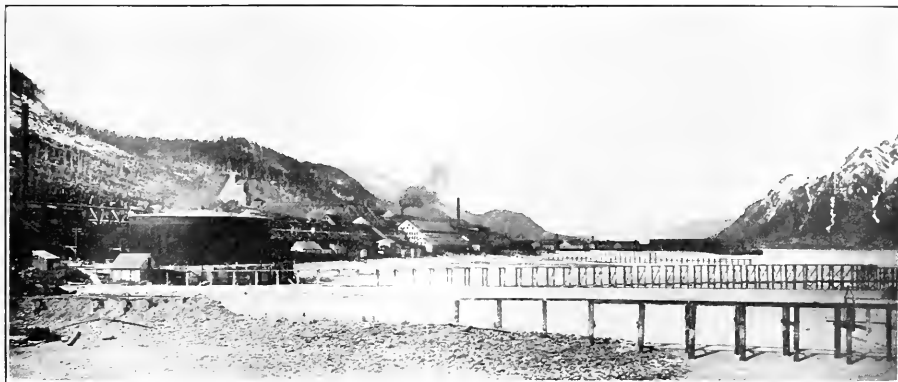
To join resources, interests, and hopes, each of the companies must have a fixed and definite interest in future discoveries. As the companies have experienced varying periods of good and ill fortune, it would have been a difficult problem to have selected any particular time as the most equitable for consolidation. However, as the situation now confronts us, the effort to consolidate should no longer be postponed; any technicalities, prejudices, or refinements of calculation should not be permitted to stand in the way of accepting immediate consolidation as necessary for the common good.

A further grave objection to, and danger from, the continuance of the present system of separate ownership is that should a change occur in the common control and management, conflicts and disputes might result that would be most dangerous and injurious to all of the com-

panies. should be suspended must be acted upon immediately, as the lives of their workmen must receive first consideration.

In reaching our decision, and in making our recommendations, we are quite aware that in the future the allotment of value may be found somewhat in error, but we believe that the basis that we have worked out and adopted is as fair and just as the present facts and disclosures will permit.

TIN ORE has recently been found in the extreme northern part of Lander county, Nevada, in an unnamed short range of hills 20 miles north of Battle Mountain, a town on the Southern Pacific railroad. What the substance was, however, remained unknown until a mining engineer who had been in Mexico happened to see it at Battle



SURFACE VIEW OF THE 700-FOOT MINE AND PART OF THE ISLAND.

panies, especially at this time when their critical condition calls for the utmost harmony and mutual support in the planning and conduct of their operations.

Another problem fraught with most serious consequences has also to be faced jointly, namely the caving in the mines, connected with the fact that the workings are largely under the sea. The very strength of the 'greenstone' hanging wall, which has been a factor of safety in the past, may be a menace in the future for if it should give way, it may be in the form of extensive slips and slides rather than the domical caving normal to softer or weaker rock structures.

The fact that there has been no subsidence in the surface debris of the 'glory-hole' during the past year, and that the dip of the orebody has flattened below the 1450-ft. level, while reserves of broken ore have been greatly drawn upon during the past three years, intensifies the seriousness of the problem. The evidence of future disturbance may remain constant for a long period or it may change rapidly from day to day.

The mine superintendent and the general superintendent, both of whom have a thorough knowledge of past cavings, are on the spot to watch daily indications. Their judgment as to when the drawing of ore reserves

Mountain and recognized it as 'wood tin,' a name given to that form of the natural oxide of tin that is characterized by a concentric banding resembling the annual growth in rings of wood. Search was immediately made for the bed-rock source of the ore, which has already been found at several places in a belt two miles long. These occurrences were recently examined by Adolph Knopf, of the U. S. Geological Survey. The ore occurs in narrow veinlets in rhyolite lavas, which were erupted in middle Tertiary time. In places the veinlets are sufficiently numerous to form low-grade lodes, but because of the small development so far done not much is known as to the size, extent, and richness of these lodes. Indications of the stronger lodes, taken in connection with their geology, are, in the opinion of Government geologists, such as to warrant further exploration.

ORE OUTPUT of the World in 1915 totaled 426,892,673 bbl., equal to 57,298,786 metric tons. The United States contributed 65.85%; Russia, 16.06%; Mexico, 7.71%; Dutch East Indies, 2.9%; Roumania, 2.82%; India, 1.73%; and Galacia, 0.98%. The 1915 yield was an increase of 7%. Since 1857 the grand total is 6,017,457,366 bbl., the United States producing 60.1%.

Formation of Nitrate Deposits

Nitrate deposits of Chile are found in the Tamarugal pampa, as the great flat desert is called. The pampa is bounded on the east by the western range of the Andes, and on the west by the coast range. It is a country characterized by an almost complete absence of rainfall. Winds that blow across the continent of South America from the east are laden with moisture. As they reach the eastern side of the Andes they are deflected upward. This movement causes a rapid cooling of the air, due to the lower temperatures prevailing at higher altitudes, and to the decrease in atmospheric pressure. Consequently, these moisture-laden air-currents precipitate their moisture most copiously on the eastern Andean slopes, and reach the western side of the mountains practically devoid of moisture. Instead of causing rainfall in the pampa country, these winds evaporate with extreme avidity whatever moisture they may come in contact with.

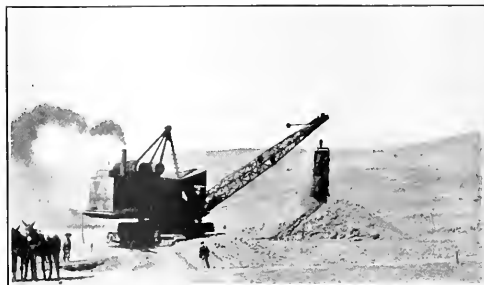
Almost equally dry are the winds that blow across the pampa from the Pacific Ocean. A short distance off the west coast of South America is a cold northerly current, known as the Humboldt, that acts as unfavorably on the climate of that coast as does the Gulf Stream favorably on the climate of the Atlantic coast of the United States. The prevailing winds along this west coast are the westerly winds coming in from the sea. As they cross the zone of cold water of the Humboldt current, they are chilled and lose most of their water-content. Then on reaching the coast, and being warmed up again, they are deficient in moisture and also have a great evaporating capacity.

Hence, whether it is the prevailing westerly winds or the occasional winds that sweep across the pampa from the Andes on the east that are blowing, the air over the pampa is nearly always extremely dry and evaporates water rather than precipitates it. These atmospheric conditions have made the pampa a desert in the strictest sense of the word. We speak of deserts in the Great Basin region of the western United States, but there one does see an occasional clump of sagebrush, or patch of greasewood, or at least a few scattered cacti, whereas one can search in vain for the smallest evidence of living vegetation over many miles of the pampa.

A consideration of these extreme conditions of parched winds, cloudless sky, and hot tropical sun have resulted in great *salar*s, or salt-beds, and nitrate deposits. The pampa is a flat plain with a gentle westward slope away from the Andes toward the coast-hills. The site of the present pampa was once a large broad valley that has been filled up with gravel, sand, and silt, washed down largely from the summits and slopes of the Andes mountains that tower above it on the east side. In past ages rainfall was more abundant in these regions than now, and the water collected in numerous depressions in the surface of the pampa in the form of inland lakes. On account of the westward slope of the pampa the lakes

formed mostly along its western edge. The waters draining into the lakes carried with them the soluble salts leached out of and formed by the disintegration of the rocks of the surrounding country, and since they had no outlet they became more and more saline, just as in the case of Great Salt Lake and the Dead Sea. As aridity increased the lakes finally dried up, giving rise to the highly saline depressions in the pampa that are known in Spanish as *salar*s. These are characterized by an abundance of sodium chloride, or common salt, in the underlying soil, and the absence of nitrate. The nitrate occurs in the surrounding higher-lying ground.

The only waters circulating at the present time across the pampa are the underground waters which have a general direction of flow from the higher slopes of the



DRAG-LINE SCRAPER IN NITRATE REGION.

Andes, their feeding ground, westward under the pampa to the sea. The upper surface of ground-water level has approximately the shape of the surface of the earth above it, but with less accentuated relief. In other words, it is nearer the surface at the points of lowest elevation and farther from the surface under the highest points. Consequently the underground waters are nearest the surface underneath the *salar*s on the west side of the pampa.

One of the striking features of the pampa is the shallow depth at which ground-water is encountered. In even less arid regions than this ground-water usually lies at a depth of hundreds, and in some cases thousands of feet, whereas, in the nitrate fields, the depth of ground-water is measured in tens of feet. Still more remarkable is the fact that in the *salar* in question, where the salt is produced, ground-water lies at a depth of only 3 to 3½ feet. Joseph T. Singewald, Jr., and Benjamin Le Roy Miller in *Bulletin of Pan American Union*.

THE BOSTON CREEK GOLD DISTRICT of Ontario has just been reported on by A. G. Burrows and P. E. Hopkins of the Bureau of Mines. The area is 45 miles northwest of Cobalt. The T. & N. O. railway traverses the field. The elevation is from 700 to 1050 ft. Principal rocks are greenstones with some volcanic fragmental rocks, the former containing gold-bearing veins. The deepest shaft is down 135 ft.

Comparison of Stopping Methods at Calumet & Arizona Mine

By Philip D. Wilson^{*}

INTRODUCTION. *The mines of the Calumet & Arizona company are near Bisbee, Arizona. The ore is found as irregular masses in limestone near porphyry or along fracture-zones many hundred feet from the intrusive. In one place the ore has a vertical dimension of 900 ft.; other orebodies are over 200 ft. but many are only 30 ft. thick. Several methods of mining are employed; they will be briefly compared.

SQUARE-SET STOPPING. The square-set system is the most flexible of any used, and where the orebody is irregular, with included blocks of waste, it is the most satisfactory. The waste can be left behind as a portion of the filling, and where the mining of too large a section is not attempted and the filling is kept within a reasonable distance of the back, it is as safe as any method. The cost of mining, including labor, powder, timber, carbide, and air, ranges from 80 cents per ton in sulphide ore to \$1 or even \$1.30 in oxidized ore. Where the ground is heavy, additional timber as bulkheads and double sets increases the cost, and in sulphide ore the excessive timber makes the risk of fire an important consideration. In a normal square-set stope the item of timber (laid down at the mine for \$17.50 per thousand) is 25% of the total cost of mining.

RECOVERING SQUARE-SET TIMBERS. The attempt to reduce expenses was made by M. W. Mitchell, foreman of one division of the mines, who devised a method for robbing a portion of the timber from a square-set stope during the process of filling. Approximately 50% of the timber can be recovered, and the cost is reduced by about 8%. The ground may be too heavy to risk removing the timbers, or the timber may be so badly damaged that it is not worth extracting. The method serves best where an orebody is mined in successive sections so that the recovered timber may be left in open sets at the edge of the stope and used when the adjacent section is being worked, as the cost of excessive handling reduces the saving to the vanishing point.

It is not feasible to recover timber from a stope over 50 ft. high. A gangway is maintained in the central row of sets on the sill-floor and chutes are built in the alternate sets on each side. Slides at appropriate places will deliver the broken ore to the chutes with a minimum of shoveling. When the ore has been extracted and the stope is ready for robbing, 6 by 6-in. braces are placed between the two diagonally opposite caps in the second and fourth rows of sets on the two floors above the sill. After the braces are put in place the caps in the second row are cut to permit of slipping-out the girts. When

these have been removed, it is a simple matter to remove the caps and the sill and first-floor posts. Waste is then introduced for filling until it reaches within a few inches of the second floor above the sill. As soon as the timber is removed, it is replaced by 'gob,' or waste, so that the walls of the stope are at all times amply supported. It is evident that by using this method in sev-



TIMBER BROKEN BY PRESSURE AT BISBEE, ARIZONA.

eral successive sections, only every third row of posts and caps is left behind in the 'gob,' while all the intermediate timbers are recovered. Success is due to the narrowness of the stopes, and the care in keeping the filling well up to the floor from which the timber is being taken.

SLICING SYSTEM. The next improvement in stopping was a slicing system, also devised by Mr. Mitchell. A block of ore broke from the back in a heavy sulphide stope, and in order to recover it, long stringers of timber were thrown across the top of the ore to support the back,

^{*}Abstract of paper to be read at the Arizona meeting of the American Institute of Mining Engineers in September.

and the ore mined from above by underhand stoping. The method is applicable to orebodies in which the hanging wall is flat and regular, and the lateral pressure not too great. Square sets may be used in mining irregular and outlying portions. There must be no large quantity of waste in the ore, for while it is possible to sort and leave some waste behind in the stope, the method loses its advantage if careful sorting has to be done.

A small sloping cut is made in every alternate set on the same side of each cross-cut for a loading-chute, but not on both sides of the same pillar, for if this is weakened, trouble is sure to ensue. The first slice is taken from raises over the whole top of the pillar, cutting it loose from the hanging wall. Where only one chute is used the broken ore fills the square sets until its normal angle of repose is reached, the remainder running from the chute by gravity. Stringers, 15 ft. long framed with 2-in. tenons, are thrown across the open slice between the caps of the topmost run of square sets and directly under the hanging wall with such blocking and lagging as is necessary to keep the stope safe and the timbers secure. The next slice is then taken across the top of the pillar. Drills set-up on columns between the stringers are used to make down-holes, pointed so that the ore is broken directly into the chutes. The slices are taken to within one floor of the sill, leaving one set of ore to be mined from below. A floor is then laid over the entire stope and 2-in. lagging is spiked vertically to the inside of both vertical runs of square sets, leaving the square sets open, when the stope has been filled for a set of chutes in each of the adjoining sections. If the ground is heavy, it is impracticable to leave the sets open, and they are lagged on the outside and filled with the rest of the stope. Upward of 50% of the stringers may be removed under favorable conditions.

The maximum height to which a section may be mined safely by this method is about 60 ft. The saving in labor, timber, and powder over the square-set system is obvious, but the main advantages are the rapidity with which the ore may be mined and the increased tonnage per man. While 5 or 6 tons per man is considered creditable in a square-set stope, it is not extraordinary in mining the pillars as above described to mine three or four times as much and in soft ground a yield as high as 50 tons per man per shift has been attained. The saving in the cost of stoping amounts to 20 or 30% of that of the square-set system.

TOP-SLICE CAVING. It was decided that the top-slice caving method as used on the Minnesota iron range, at Cananea, and elsewhere, might be applied to a large body of oxidized ore in which heavy and swelling ground made the cost of square-sets excessive. An inclined top-slice caving method was devised by Mr. Mitchell; this reduces the handling of ore in the stope, incidental to ordinary top-slicing, to a minimum. The method is applicable to the same conditions as ordinary top-slicing, that is, to uniform ground too heavy for economical square-set stoping and caving readily, but kept under control. There should be reasonable assurance that no

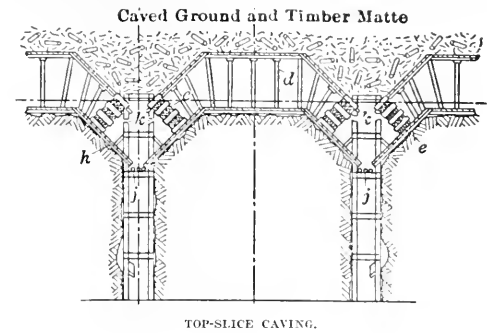
ore is left unextracted above the body to be caved, as the subsequent mining of this would be attended by many difficulties. In common with ordinary top-slicing, ventilation is poor in the stopes. Some ore is sacrificed in the process even under the most satisfactory conditions. The orebody is laid out in 45-ft. sections that may be mined for the width of the ore to a maximum of 80 ft. Permanent six-post raises are driven, preferably in waste at the edge of the ore, to a height equal to the top of the orebody. One compartment is used as a chute, the other for passing timber and men. Parallel rows of square sets are carried the width of the ore on the three floors directly beneath the hanging wall. A pillar 40 ft. wide is mined by horizontal slices from the top downward, one-half from either side simultaneously, and the back allowed to cave as stoping progresses. The first cut is taken from both sides simultaneously across the pillar at the end of the ore and is supported by standard square sets. As the slice retreats toward the main drift, the rows of square-set posts first erected are shot and the back caved, leaving at least two open sets between the working-face and the caved ground. To prevent the square sets being crushed by the weight of caved ground, small bulkheads are built under the lower caps of this floor resting upon the angle-timbers. The posts are then cut at points directly under the angles, thus transferring the weight from the square sets below to the solid ground in the pillar. When the upper slice has proceeded far enough from the extremity of the section so that the ground first caved is solid, preparations may be begun for the second slice. After the preliminary cut has been made, the major portion of the ore is 'slabbed' directly into the chute-sets, leaving one-third to one-fifth to be shoveled. It has been found that the maximum thickness of slice that can be safely carried in these mines is 10½ ft. and slices of this thickness are not attempted until the fourth slice is taken and the caving mat is under perfect control. If waste is encountered in the ore, it is feasible to sort and leave it behind to become incorporated with the caved ground and timber mat, but like the method last described the system loses most of its advantage where careful sorting is necessary. A 10% reduction in cost is gained over ordinary top-slicing. The labor cost is cut about 15% and the item of powder is reduced. The ore may be mined rapidly and safely in the heaviest kind of ground. An output of about 10 tons per man per shift or a total of about 125 tons per day can be maintained from each section.

CUT-AND-FILL SYSTEM. A cut-and-fill method was devised by Oscar Gilman; this permits of a minimum of timber, low cost, flexibility, and tonnage. The method may be used wherever the ore and country-rock are strong and solid, and while the width of each section is limited to 40 ft., the length and height of stopes are limited only by the extent of the ore. Cross-cuts are driven at 10 ft. intervals, and a cutting-out stope is started by enlarging the cross-cut with stoper-drills. When it has reached a height of 8 or 9 ft. above the rail, hitches are cut in the walls and temporary stringers are

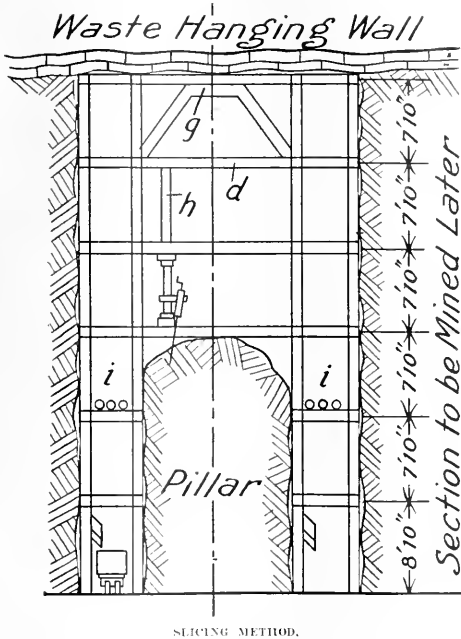
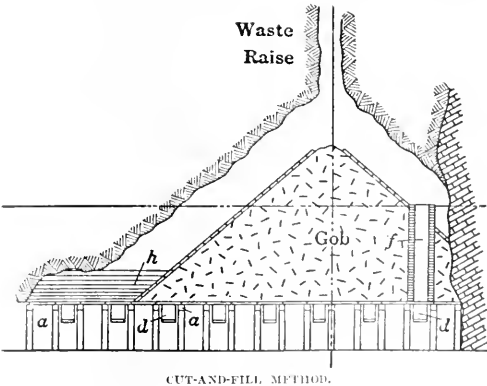
thrown across the cross-cut at 5-ft. intervals, 5 ft. above the rail. Flooring is laid upon the stringers so that ore may be loaded directly into cars.

During this preliminary preparation, at about the centre of each section a raise has been started to connect ultimately with the level above, and to be used for timber and filling. When the 10-ft. limit has been reached, waste is admitted and forms a cone extending out toward the edges of the stope. The back may be supported in any weak spots while the next slice is being taken by temporary stulls or bulkheads resting upon the waste. As the chutes under this fill are covered they are abandoned and the ore as broken runs upon the sloping

each stope on the sill-floor is left to be mined from below. The cost under this system is low. It will average about 50c. per ton. Although slightly more expensive, than the old shrinkage method, the factor of safety more



than compensates for the small increase of cost over the more hazardous system. The ventilation is good and the efficiency of the men high. An average yield of 12 tons per man per shift can be maintained under normal conditions. The daily output of each section will average



floor and is drawn from the chutes still open at either end of the waste.

Carrying a stope between two filled sections is at best an uncertain operation and the risk may be avoided entirely by taking the sections in succession as described. The ridge of ore 35 ft. wide and 14 ft. high between

100 tons per day and may be crowded to 150 or even 200 tons.

SUMMARY. The cut-and-fill system is easily the cheapest and most satisfactory in every way where conditions are favorable. The item of timber, usually a large one,

COMPARATIVE STOPING COSTS								
Method and Conditions	Labor	Explosives	Timber	Candles or Carbide	Air	Other Supplies	Total	
Square-set, oxidized ore, heavy ground.....	\$0.73	\$0.06	\$0.34	\$0.01	\$0.12	\$0.01	\$1.30	
Square-set, oxidized ore, average ground.....	0.60	0.05	0.25	0.01	0.10	0.01	1.05	
Square-set, oxidized ore, robbing timbers.....	0.61	0.05	0.16	0.01	0.10	0.01	0.97	
Top-slice caving, old method, oxidized ore, heavy ground.....	0.63	0.07	0.20	0.01	0.10	0.03	1.04	
Top-slice caving, oxidized ore, heavy ground.....	0.54	0.01	0.21	0.01	0.10	0.03	0.93	
Slicing, oxidized ore, average ground.....	0.51	0.05	0.20	0.01	0.06	0.02	0.85	
Square-set, sulphide ore, average ground.....	0.49	0.01	0.19	0.01	0.01	0.03	0.80	
Slicing, sulphide ore, average ground.....	0.43	0.03	0.15	0.01	0.03	0.01	0.66	
Cut-and-fill, Gilman method, sulphide ore, good ground.....	0.34	0.01	0.07	0.01	0.01	0.01	0.51	
Cut-and-fill, old method, sulphide ore, good ground.....	0.22	0.01	0.04	0.01	0.01	0.01	0.46	

is much reduced and the risk of fire is virtually eliminated. While any large 'horse' in the ore may be kept separate and left in the fill, any attempt at close sorting is inadvisable. As in the case of the slicing system, if the ore is fairly clean the greatest ultimate economy will be gained by mining it all as it comes, without attempting to sort. The consequent low cost obtained by mining a large tonnage rapidly will more than off-set the increased cost of handling and treating a slightly lower-grade ore. In neither system can the grade of ore be controlled as closely as in the square-set or top-slice caving methods. Where the ore is irregular or badly mixed with waste, the square-set method is the best. If the stope is in good condition a considerable proportion of the timbers may be extracted safely as it is being filled.

For a heavy uniform orebody the inclined top-slice caving system is recommended. While it still retains some of the disadvantages of the old-fashioned top-slice, it is in many ways an improvement over the older method. The principal advantages are the saving in labor and powder, and the rapidity with which the ore may be mined. The unfavorable features are those of all top-slice caving methods: the almost inevitable sacrifice of some of the ore, narrow work, poor ventilation in the stopes, and the fact that the ground above is so badly broken as to render the expense of future work on upper levels so great as to be almost prohibitive. The slicing system finds its chief application to fairly regular orebodies in not too heavy ground. Under favorable conditions the cost is lower when using this method than when using any of the others, with the exception of the cut-and-fill method. The saving in labor and timber is appreciable over square-set stoping and the cycle of preparing, mining, filling, and abandoning a section is normally a short one. This feature, in addition to permitting a large daily output, reduces the repair cost incidental to keeping a section of the country open over a long period. The introduction of these methods has effected a large saving to the Calumet & Arizona Co. during the past few years without endangering the safety of the men or of the mines.

Electric Pumps

Pumps driven by electricity are either of the reciprocating type or the centrifugal type. Generally speaking, a reciprocating pump driven by an induction motor is suited to pump a regular amount of water against a head that may be varied at pleasure. With a centrifugal pump, on the contrary, the quantity of water can be regulated, but the head cannot be materially changed without making structural alterations in the pump. A reciprocating pump is adapted for work in mines where the flow of water is steady, and where it is a convenience to be able to transfer the pump to different levels as the mine is deepened. The centrifugal pump cannot be shifted to different levels without impairing the efficiency, but it can take care of a varying flow of water

as a consequence of the change of seasons. An advantage of the centrifugal type is that the quantity of water pumped can be regulated within comparatively wide limits, with but slight variations in the efficiency, by simply opening and closing a valve on either the suction or the discharge-pipe. A reciprocating pump, on the other hand, must be run at constant speed, unless the speed of the motor can be varied, as with a direct-current motor. But a centrifugal pump may be altered for work on different levels by changing either the number or the diameter of the impellers. In smaller sizes a centrifugal pump is inefficient, but the efficiency increases with the size. Pumps of a capacity of 600 to 1200 gal. per minute can be easily maintained at an efficiency of 55 to 65%.

At a Michigan mine 900 ft. deep, where the flow is 30 to 40 gal. per minute, there is a motor-driven horizontal plunger-pump of a capacity of 125 gal. per minute. On Sundays and holidays the pump can be operated from surface, the high and low-water marks in the sump being furnished with an electric device for signaling to the hoist-house. At another Michigan mine 1150 ft. deep, two motor-driven plunger-pumps are employed. One is triplex and has a rated capacity of 95 gal. per minute, the other is duplex and has a rated capacity of 125 gal. The flow at this place averages 50 gal. per minute, occasionally reaching a maximum of 150 gallons.

Figures on the cost for maintenance of centrifugal and triple-expansion steam-pumps show a decided advantage for the centrifugal type. The following figures from a Michigan mine for eight pumps, four of each type, during one year:

	Centrifugal	Steam
Shop labor	\$717	\$760
Labor on pumps	690	590
Supplies	503	2021
	\$1910	\$3371

It is seen that the labor cost was about the same for each, but that the steam-pumps had a greater expense for supplies, mostly for packing for the water-end. The centrifugal pumps mentioned had motors with wound rotors and a device for short-circuiting the secondary current and relieving the brushes from wear by lifting them from the rings. These pumps were rated at 900 gal. per minute each. The flow of water increased to 1100 gal. This was too much for one pump and not enough for two, so it was necessary to start and stop one pump frequently. Later it was found that by increasing the speed of the generator in the hydro-electric power-house from 60 to 62½ cycles per second, each pump could handle 1200 to 1300 gal. per minute. But this overloaded the motors and, after running some time, it was found that the insulation had been baked until it was brittle. This made trouble when it became necessary to repair the windings. A drop in efficiency will also overload the motor, so that it is well to provide centrifugal pumps with motors of a size larger than for the normal head and quantity.

Mining in Arizona

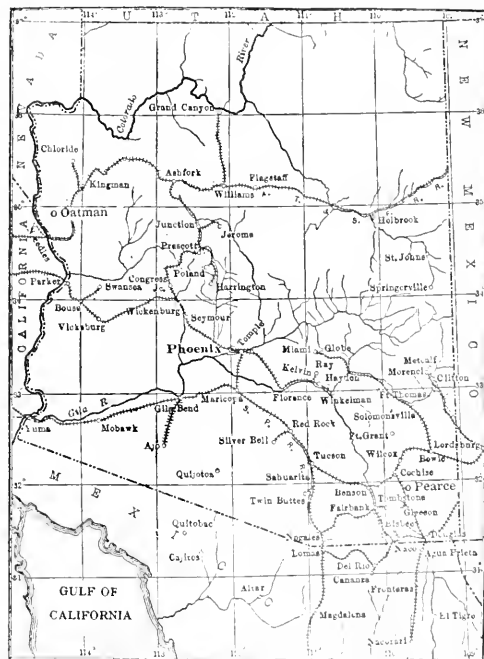
By Charles F. Willis

Mines and smelters in Arizona have been working at such high pressure this year that they are making record outputs of all metals. If they continue to work at the present rate for the remainder of the year they will produce over 600,000,000 lb. of copper, against 450,000,000 lb. in 1915. A corresponding increase in the output of the precious metals, and in lead and zinc, combined with higher prices, will make the total value of the current year nearly double that for 1915, which was about \$88,000,000. Aside from effort to take advantage of what was an unusually active market, several factors have aided this increase, such as resumption of the Clifton-Morenci mines in January. The International smelter, which reduces Inspiration concentrate, contributes the greatest part of the increase, as this plant is supplying about 25% of the total copper. Marked increases and improvements were made at the United Verde, Miami, Calumet & Arizona, and Old Dominion mines. The Saseo plant in Pima county was again blown-in. The railroad to Ajo was completed, and work has been started at the New Cornelia on a 400-ton leaching plant. There is great activity in the production of gold, especially in Mohave county, and the high price of zinc has stimulated production at the Tennessee, Union Basin, and Kingman zinc mines, which are in the same region.

Announcement that the U. S. Bureau of Mines had authorized a mining experiment station at the University of Arizona, is a step forward. Permanent progress of the State is dependent on mining. Over 25% of the males here are employed at mines. It was not unexpected that Tucson would be chosen as the site of one of the first three stations authorized, for while the city is not the geometrical centre of the State, it is in almost every other way. Tucson is on two main railroads, and has other lines branching from it. It is the centre of the State's educational activities, of the State Bureau of Mines, of the State University, the centre of population, the centre of the State's copper production, and the centre of money distribution. It is connected directly with all of the largest copper centres of Arizona save Jerome. Although the U. S. Bureau of Mines has an independent personnel, its presence is of great advantage to the students of the University of Arizona College of Mines. The influence of noted investigators, the use and observation of machinery that would not otherwise be available, an insight into methods of research of great problems, all of these are of benefit to the student. This, coupled with the fact that the ground has already been broken for a new mining and engineering building of the University, is important. The last Legislature appropriated \$75,000 for a new building, contingent on the University authorities raising an equal amount. Through the generosity of the mining companies, who contributed in proportion to their copper-output, \$100,000 has been

raised, and the plans for the building are actually under way.

It seems to be generally considered that a State advancing in metal output as is Arizona, can have but few unsolved problems; an analysis of the situation will show that this is not so. Over 95% of the copper produced in the State is from 13 companies, out of 400 producers. Although mining contributes both directly and indirectly about 66% of the State's taxes, over 90% of this amount is paid by these 13 companies, practically bearing the burden for the entire State. There are thousands of mines here waiting for suitable treatment



MAP OF ARIZONA.

methods. At present, with no facilities for metallurgical research, the only hope of the smaller companies having such problems is to sell to the larger corporations having the capital to carry on research. This is proved by many recent changes of ownership. The Calumet & Arizona spent a large sum in devising a process for its Ajo ores, although the mine there is one of the oldest in the State. Lead, zinc, and molybdenum ores are others requiring attention.

Probably the greatest discussion of the past month has been on the proposed copper tax. This would hit Arizona hard, causing the operators to pay approximately \$1,000,000. Arguments have not been against a tax, but rather on the unfairness of singling out the copper industry for taxation. When the price of copper reaches a normal level, such a tax would be extremely burdensome, in many cases prohibitive.

The Parker district offers good opportunities to mining men. The Manning & Roeder property was acquired last week by J. L. Melver and Geo. W. Long, the men who discovered and developed the United Eastern gold mine at Oatman. Associated with Melver and Long in the purchase are W. K. Ridenour of the Telluride Mining & Development Co., and A. L. Kreiss. The property consists of 23 claims, 8 miles north of Parker on the west side of the Colorado river. Over 3000 ft. of development has been done and extensive bodies of copper ore have been opened. The purchase price is \$300,000, with a substantial cash payment, the balance to be paid in installments extending over two years.

By a first payment of several thousand dollars the sale of the 50 copper claims of C. J. McNulty and M. McBride on Copper creek, 10 miles south-west of Prescott, has been consummated, and the group is now in the hands of the Daly-Crawford-Lewisohn syndicate. It is stated that the consideration was over \$300,000. The ground has been thoroughly prospected, the original owner, McNulty, having devoted more than 15 years to this work.

The largest mining deal ever closed in the Walker district, south of Prescott, as well as in this field generally, is that by which the Sheldon Mining Co. succeeds to the holdings of the Major Mining & Milling Co., in which the cash has been paid and the titles cleared. All conflicting interests of the estate of H. T. Andrews, deceased, Stucky brothers, the Metals Mining Co., the Empire Mining Co. and the Major Mining & Milling Co. have been merged with the Sheldon, embracing a group of nine gold-copper mines of attractive rating. With this transaction complete, operations will soon begin on a large scale. It is probable that the Eureka and Sheldon holdings will be the base of operations. John F. Pell, of Newark, New Jersey, is to head the Sheldon as president. Negotiations to effect this important merger have been under consideration for several months. Some of the oldest and best known of pioneer gold mines in this county that had lain idle for years are now assured of becoming active, and probably highly productive.

Rapid progress is being made at the New Cornelia company's leaching-plant at Ajo. After various delays construction progress is now satisfactory. The leaching vats are 88 ft. square. The power-house is 160 ft. square, and the electrolytic tower-house 160 by 280 ft. To feed the cement-mixers and keep the concrete work going, a temporary crusher is at work continuously, providing 350 tons of crushed rock per day.

After lying idle, water-logged, and caved for years, the old Harqua Hala Bonanza gold mine has come to life with the opening of another rich shoot in new ground north of the old workings-shaft. The vein widens with depth. It might be assumed that a mine which has produced \$1,000,000 would be a deep one, yet this is not so. It was worked in the early days to a depth of 100 ft.; levels were driven at intervals of 50 ft., and some of them for a considerable length. But the deeper ore is still undisturbed, save for the new work. The ore also carries copper. The 10 stamp mill is crushing ore from the up-

per levels. After the winze has been sunk 200 ft., and the ground further explored from it, a three-compartment vertical shaft will be sunk. The mill will also be greatly improved.

Another suit, further complicating the already tangled affairs of the Hull Copper Co., was filed recently at Prescott. The names of Wm. H. Kemp, G. O. Bowman, Benj. P. Walton, Andres B. Tarbett, and John H. Page appear as plaintiffs; the Hull Copper Co., Geo. W. Hull, Mrs. Mary A. Hull, S. F. Denison, Will L. Clark, Chas. W. Clark, W. A. Clark, and the United Verde Copper Co. are named as defendants. One of the principal allegations of the plaintiffs is that a number of shares have been wrongfully issued to Hull and his wife. Other complaints petition for a disclosure of all facts in connection with the recent deal for the transfer of Hull's controlling interest in the Hull Copper Co. to the Clark interests. A temporary injunction preventing this is asked. The history of the Hull litigation dates back several years. All the company's funds were exhausted and Hull, it is alleged, personally advanced large sums for the continuation of development. He eventually filed suit for an accounting. The hope is expressed that the new litigation may result in some Court action that will make possible the transfer of all the Hull ground to the United Verde, and its development by that company. It is certain, however, that much time must pass before this is brought about.

ON ACCOUNT of the present high price of mercury used in the manufacture of mercury fulminate, detonators have greatly advanced in price. Manufacturers are seeking a substitute to partly replace the fulminate. By the use of a suitable base charge and of a fulminate-chlorate as a primer in the reinforced detonator, about one-half as much fulminate is required for a cap of given strength. Commercial blasting-caps have been manufactured containing both TNT (trinitrotoluene) and tetryl as the base charge. About 0.40 gram of base charge and 0.32 gram of 90:10 fulminate-chlorate primer make a cap of the No. 6 grade. It is important to use as a factor of safety about 50% excess primer above the minimum quantity required for complete detonation of the base charge. It is also important to use a base charge not too insensitive to slightly moist fulminate. Any explosive proposed for use as a base charge should be thoroughly tested to meet any possible conditions of treatment or storage to which the blasting-caps are likely to be exposed in practical work, for the failure of a single cap may be a serious matter. On account of its insensitiveness to slightly moist fulminate, TNT has proved an unsatisfactory base charge.—Abstract from Technical Paper 145 of U. S. Bureau of Mines, by G. B. Taylor and W. C. Cope, entitled "Sensitiveness to Detonation of Trinitrotoluene and Tetranitromethylanilin."

NITRO-GLYCERIN of 50% strength is now selling at \$19.50 per 100 lb., or \$390 per ton.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

To CONVERT specific gravity to Baumé gravity, divide 140 by specific gravity and deduct 130. The result is the Baumé gravity (approximate). To convert Baumé gravity to specific gravity, add 130 to Baumé gravity and divide into 140, giving specific gravity (approximate). Specific gravity multiplied by 8.331 gives pounds per gallon.

THE DANGEROUS GAS CO should not result from the explosion of a modern high explosive. The results of blasting should be CO and H₂O, providing the explosive is properly compounded and detonated. It has been said that the carbon contained in the paper wrappers of dynamite sometimes makes CO gas. As little as 0.25% of CO in the air may affect a miner, while 7 or 8% of CO₂ (called 'choke damp') is necessary to cause distress.

IN BLASTING, the more nearly the charge of explosive is adjusted exactly to the burden of rock, the more complete should be the explosion and the less should be the fume. The pressure of the explosion is greatest when a charge is carefully adjusted to the burden, the thermodynamic changes being interdependent. Over-charging of holes in blasting is customary, in order to ensure a successful shot.

THE HIGHEST habitation in the world is stated to be in Peru. Professor Isaiah Bowman reports that he crossed the Andes by the passes between Antabamba and Cotahinasi, and at 17,100 ft. altitude saw a thatched stone hut that sheltered a family of five. These natives were apparently quite healthy, and "three rosy-cheeked children almost as fat as the sheep about them were playing with balls of wool." A man accustomed to low altitudes could not live at so high an altitude without suffering ill-health.

A GOLD TRUST-FUND is proposed for simplifying commercial settlements between the different North and South American countries. This would save unnecessary transfer of gold in adjustment of balances. A unit of money equal to one-fifth of the American gold dollar was approved at a recent conference in Buenos Aires. If adopted by the various countries, this would provide a uniform basis of transaction among all the American nations. It will also afford a standard likely to be adopted for gold coinage by South American countries when they find themselves able to employ a gold basis.

COMPRESSED AIR can be utilized in a variety of ways around an industrial plant. Not only the mechanical force of the escaping jet is used, but it is an efficient drier, and, when equipped with spray, a moistener. For cleaning out-of-the-way nooks nothing can equal it.

It agitates cyanide or flotation liquids, ventilates mine workings, and blows factory whistles. It is clean, and when it has done its work is in nobody's way. Air-pressure is one of the best ways of quickly and thoroughly forcing the water out of boiler-tubes, as well as testing for leaks in pipes or boilers.

ELECTRIC HAULAGE underground is well liked at large mines where the tramping can be concentrated on a few levels, as in the extraction of large mass deposits of copper, iron, or low-grade gold ore. In mines where the tramping is scattered on many levels, as in the Michigan copper mines, or in mining narrow lodes of high-grade ore, electric haulage is not so well adapted. The cost of maintenance of underground electric traction in a large mine is likely to be about 15c. per ton-mile. Of this, 2c. would be for power, 5c. for maintenance of track, 4c. for maintenance of trolley, and 3c. for maintenance of locomotives. Similar costs were found necessary in the Copper Queen mines at Bisbee.

PRICES of lumber during 1915 are given in a bulletin of the U. S. Department of Agriculture. The most expensive woods in a list of 27 were cypress, yellow poplar, hickory, and ash, all worth between \$20 and \$23.50 per 1000 ft. Of the soft woods, white pine was \$18, hemlock \$13, spruce \$16.50, redwood \$13.50, cedar \$15.50, and tamarack \$11. Southern yellow pine, of which a great quantity was cut, constituting 30% of the total, was \$12.50. Douglas fir, which contributed 10% of the country's cut for the year, was \$10.50. Of the hardwoods, oak sold at \$19 per thousand, maple at \$15, birch at \$16.50, and cottonwood at \$17.50. Oak, white pine, and hemlock are the only varieties other than yellow pine and Douglas fir, of which over 2,000,000,000 bd. ft. was cut.

THE SLACK-CABLE SYSTEM for removal of ore from underground is being tried at the Quick Seven zinc mine, in the Joplin district of Missouri. The excavating outfit consists of a mast or gin-pole, supporting a track-cable upon which runs the bucket, and the engine necessary to operate the bucket. The engine has two drums, one of which, by a direct pull, loads and hauls the bucket; the other, by means of a set of double blocks, tightens the track-cable in order to raise the bucket off the ground. The system is installed at the side of a large cave-in at the mine. There is a 115-ft. face of ore, extending from a depth of 160 ft. to within 15 ft. of the surface. The ore averages 17% zinc. One great advantage of the slack-cable system is that it works equally well in dry ground or in water. In other words, if the cave in at the Quick Seven were completely filled with water, the bucket could operate at nearly the same efficiency as if it were drained. The upper 15 ft. is of sand and clay. This will be washed down and disposed of hydraulically, thus leaving the orebody exposed to the direct action of the bucket. One Morris and one Cameron sand-pump have been installed for this work.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

WASHINGTON, D. C.

A SESSION WITHOUT VALUE TO MINING

This session of Congress is about to close without having done anything for mining, save what is involved in the general appropriation bills, but these have included no new legislation bearing on the industry. The bill to create a commission to codify the mining laws has failed in final action, and is considered dead for this session, inclusive of the short session beginning in December. While considerable enthusiasm was manifested at the beginning by members of the House for the passage of such legislation, opposition developed in the House Committee on Mining, which decided that if there was to be any codification at all, it should be done by the Committee itself. The bill that passed the Senate was side-tracked, similar treatment being given the bill of Representative Foster of Illinois. The whole Mining Committee has now adjourned *sine die* for the current session, without taking action, and all that has been held out is hope that something would be done at the short session. This, however, will be crowded with business, particularly in anticipation to the inauguration of the new President. What has vexed mining men particularly is, that while there has been general sentiment in Congress favoring codification of the mining laws, legislation should be held up by a few men, one of the most influential being James Wickersham, delegate from Alaska.

A final measure of interest to the West has been the passing, by the House, of the bill to authorize the Secretary of the Interior to lease for production of oil and gas ceded lands of the Shoshone or Wind River Indian Reservation in Wyoming. The act follows the lines of usual leasing bills. The Senate has yet to act on it.

HUMBOLDT, ARIZONA

NOTES ON IMPORTANT MINES OF THE DISTRICT.

The Stoddard and Copper Queen properties, 6 miles from Mayer, are erecting a joint mill of 100 tons' capacity. Each mine is about 1000 ft. from the mill-site, and the ore will be hand-trammed from them on a slight down-grade to the mine ore-bins. The two trams arrive at the bin with a difference in elevation of 8 ft. The mine ore-bin is flat-bottomed with two compartments, having provision for dumping the ore from either mine in either compartment. The run-of-mine ore will be taken from the bin by belt-conveyor to a Gates crusher. The topography of the country necessitated the digging of a pit for the crusher-discharge, which is then conveyed to the mill-bin by an inclined belt-conveyor. The mill-bin has a sloping bottom and holds 100 tons. A Marx mill in closed-circuit with a Dorr duplex classifier prepares the ore for the Gahl flotation machine. This consists of a 16-cell rougher, and a 6-cell cleaner, a diaphragm-pump being used to elevate concentrate from the rougher to the cleaner. All flotation tailing flows by gravity to three double-deck Deister tables, the tailing from which go to waste. Concentrate is dewatered in a Dorr thickener and 2 Oliver filters. Instead of a concentrate-bin, a long wide chute will be used to deliver the concentrate by gravity from the filters to trucks for haulage to Mayer, the nearest shipping point. The building is of wooden-frame construction with corrugated-iron walls and roof. It is expected that the plant will be ready for operation within a month,

possibly sooner. It was designed by Kenyon Burch. The Gahl flotation machines are the same as those devised at the Inspiration, consisting of air agitation exclusively. The ore contains 3% copper.

The Big Ledge Development Co., owning the Henrietta and Butternut gold-copper mines near Poland Junction, has bought the old Treadwell smelter at Mayer, and the Hackberry mine near-by. The company proposes to re-model the smelter along modern lines, using the Hackberry ore as basic flux for its own highly silicious ores.

The Big Pine gold mine owners, 18 miles from Prescott in the Groom Creek district, have purchased the old Mascot mill at Crown King, and will use most of the machinery in the construction of a mill at their property. Crushing by rolls, and counter-current decantation will be the cyanidation treatment. Precipitation will be by zinc-dust. Mr. Dunning is general manager.

Two miles west of Humboldt is the Camp Anderson lead-silver mine. A mill is contemplated, using Huntington mills and gravity concentration. Development is opening a good vein.

The New Year is an old property in the Chaparral district, 5 miles from Humboldt, recently re-opened by Prescott and Phoenix capital, under the superintendence of Claude Ferguson. The shaft was re-opened and thoroughly re-timbered to a depth of 200 ft. Operations were then suspended until two weeks ago, when a small crew commenced on development. One drift will be driven on two shifts, and another on day shift only. The shaft is inclined at about 70°; water and waste is raised and supplies lowered in a torpedo bucket, using a 15-hp. Fairbanks-Morse electric hoist, which has given good service for that purpose.

At the Consolidated Arizona the frame-work for a new temporary sample-mill is about completed. The old mill was burned on June 9. At present the company is handling only the Swansea ore and high-grade custom ores and concentrates, in addition to its own supply from the Blue Bell and De Soto mines. When the temporary mill is completed, the company will be able to handle its usual quota of custom ores. When the pressure of other work has slackened, the company proposes installing a modern change-room for its men. This will be a much needed and greatly appreciated improvement.

BUTTE, MONTANA

SILVER PRODUCTION—DYNAMITE FACTORY.—ELECTROLYTIC ZINC.

—SHAFT WORK AT BUTTE & SUPERIOR.—BUTTE-DULUTH AFFAIRS.

Few people realize the great quantity of silver recovered in this district. Anaconda produces 10,000,000 oz. yearly as a by-product from its copper. The Black Rock mine of the Butte & Superior yields 10,000 oz. daily. As the average price of silver for the first six months of this year has been 20% higher than that of last year, the increase has added considerably to the profits of all operating companies at Butte, also a good help to the smaller companies all over the State.

Construction work is being hurried on the Dul'ont powder-plant being built on a 1200-acre tract 8 miles west of Butte. Several buildings, to be used for storing powder, are complete, and have been surrounded with earth embankments to lessen

the danger from explosions. The factory proper is in a remote part of the ground, and the office buildings will be near the main road between Butte and Anaconda. Spur-lines have been constructed over the property from the main line of the Butte, Anaconda & Pacific road. Butte uses 6,000,000 lb. of dynamite per year. The nearest powder-plant is at DuPont, Washington, and as the freight-rate on explosives is high, a great saving will be effected by manufacturing the fracture nearer the point of consumption. Parts of Utah and Idaho will also be supplied from this plant. The factory will be completed late in December, and will manufacture dynamite and gelatine only. Nitric acid will be made from Chilean nitrate. Sulphuric acid will come from the Washoe plant at Anaconda. When working at normal capacity 150 men will be employed.

One unit of the Anaconda electrolytic-zinc plant at Great Falls has been started. Excellent progress has been made in construction, and the whole plant of 2000-ton capacity of ore per day is expected to be in operation by September 1. The Emma mine will supply most of the ore. Its shaft is in the heart of the residence district of Butte, and it will be difficult to construct a railroad spur to its ore-bins. The company had an option on the Czar and Travonia Fraction claims adjoining the Emma on the south-west, but allowed the option to lapse. The purchase price was \$300,000, and a payment of \$50,000 had been made. Why the property was not taken over is not known. The Emma vein extends through the Czar, and both claims could be easily worked through the Emma shaft.

The king-bolt on a loaded skip broke in the Black Rock shaft of the Butte & Superior, and the skip containing 5 tons of ore dropped from the 150 to the 1100-ft. level, where it lodged across the shaft, after having knocked out the timbers in all four compartments for a distance of 50 ft. A complete shut-down for 10 days was necessary while the shaft was repaired. The fact that a wreck of this kind usually puts all the compartments of a shaft out of commission was one reason why the management decided to sink separate shafts for hoisting ore and lowering timber. A typical Butte shaft is shown in Fig. 1. The new shafts are shown in Fig. 2 and 3. They are separated by a 50-ft. block of solid ground. The cage that lowers timber, transfers men, etc., is locally known as the 'chippy-cage.' Two compartments in the new shafts will be devoted to chippy-cages, to be run in counter-balance, effecting a great saving in power. By a combination of sinking from the surface to about 800 ft., and raising from the 1000, 1200, 1300, 1400, and 1500-ft. levels, the ore shaft was completed from the surface to 1500-ft. in 6 months. This is a new record for the Butte district. The average rate of sinking in hard granite, timbering as the work proceeds, is less than 100 ft. per month. The shafts will have separate stations on each level. The confusion that results from unloading timber on a station where ore is being dumped into a skip-chute will in this way be eliminated. Jackhammer-drills weighing about 40 lb. each were used in sinking. A round consisted of 24 to 30 6-ft. holes. All men working in the shaft were paid a bonus for speed, and with three machines the average drilling time per round was 2½ hours. Surveying was done under difficulties. On the surface the temperature ranged from zero to 40° below zero, the ground moved continually, several of the sights underground were short, and the timber-men had to be watched to get them to line-up the timbers accurately. Regulation shaft timbers were used in all the raises, and the connections were made with a maximum error of 2-in. The error is distributed among several sets, so that it is not noticeable in ordinary shaft operation.

The Butte-Duluth property has been leased to Alfred Frank and associates of Salt Lake City for 5 years. Repair work will be started immediately, and it is expected that the plant will be operating at full capacity by September 1. The property includes the Macaroni, Montgomery, Park, and Recorder claims, and parts of the Altona, Colleen Bawn, and Amazon. The ore was formerly mined in open-cuts with electric muck-

ing-shovels. Mining from open-cuts will be continued, and in addition the Montgomery shaft will be sunk deeper and much exploration work will be done. The mill will be enlarged to treat 500 tons of ore per day. The ore is crushed to 8-mesh with a gyratory, rolls, and Symons disc-crushers. It is then leached with sulphuric acid in Dorr classifiers, and the copper precipitated from the solution by electrolysis. It has been reported that a flotation plant will be installed and that leaching practice will be abandoned, because of the scarcity of sulphuric acid. Flotation does not seem practicable, as nearly 50% of the copper occurs as carbonates. The property was closed by

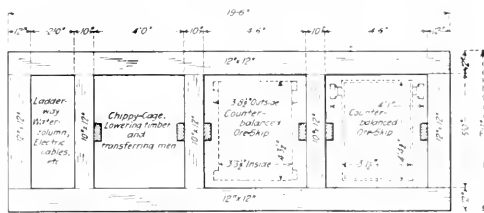


Fig. 1

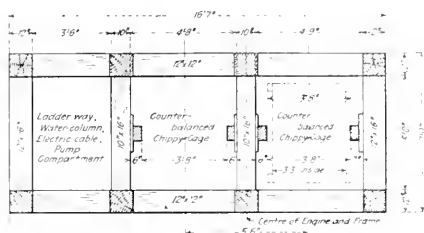


Fig. 2

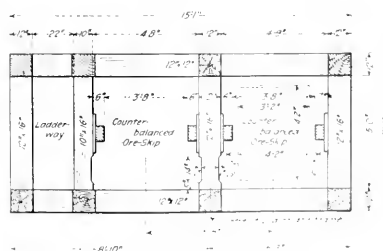


FIG. 1 IS A TYPICAL BUTTE SHAFT; FIG. 2 IS THE NEW CHIPPY SHAFT AT THE BUTTE & SUPERIOR, AND FIG. 3 IS THE NEW HOISTING SHAFT AT THE SAME MINE.

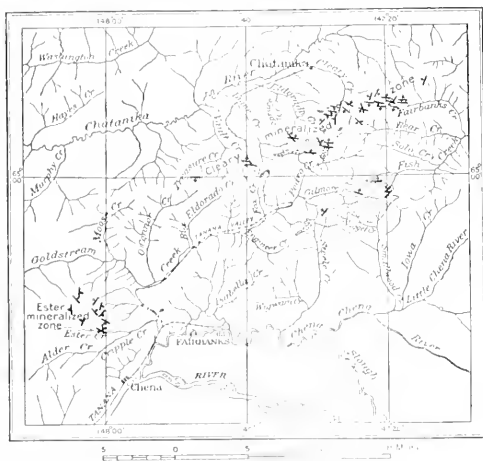
Court action brought by the Provident Securities Co. for non-payment of interest on bonds. A receiver was appointed. Claims for labor and lumber amounted to \$75,000. Until all the debts are liquidated the Butte-Duluth will be technically in the hands of the receiver. Under the terms of the lease the company will receive 50% of the proceeds after the cost of operation, construction, and the expense of receivership have been deducted. After February 1919, Mr. Frank agrees to pay the sum of at least \$7500 every three months. These payments will take care of the interest on the outstanding bonds of the company. Mr. Frank is well known in Butte. He was formerly consulting engineer for the Heinz interests. He took over the affairs of the Ohio Copper Co. in Utah under a similar receivership, and his success with that property was a big factor in influencing the bond-holders to give him a lease on the Butte-Duluth property.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

In Bulletin 649 of the U. S. Geological Survey, Alfred H. Brooks describes the antimony deposits of Alaska. Up to the recent drop in the price of the metal there had been many inquiries regarding occurrence of the ore in the Territory, and in 1915 the output was 833 tons of crude ore worth \$74,900. Stibnite has been found in 67 localities in Alaska, in nearly all the gold-bearing areas, but only a few deposits have been studied in detail, especially those in the Fairbanks district. Most of these occur in mica and quartz-schist. The country-rock of the lodes is sedimentary as a rule. The deposits show little oxidation. Fairbanks last year shipped 685 tons of 58% ore, from the Scraftord, Stibnite, Gilmer, and Chatham



SKETCH SHOWING DISTRIBUTION OF LODES AT FAIRBANKS.

Creek mines. Operations were on a small scale and chiefly by open-cuts. Details of other centres are given in the 64 pages comprising the publication.

ANCHORAGE. In the *Excavating Engineer* for August, L. T. Russell, briefly describes progress of the Alaskan railroad. The Anchorage division, in charge of Frederick Mears, is completed from Anchorage to Peters creek, about mile 135. The Fairbanks division is in charge of Thomas Riggs, while the Seward section is under W. C. Edes. The latter line is that of the Alaska Northern, acquired by purchase. Anchorage is the base of supplies for construction in both directions. Bucyrus steam shovels are in use along the line.

BRIERLY. The 3000-ton gas schooner *Kushikwim River* recently arrived here from Seattle with a full cargo, including a Union Construction Co., San Francisco, dredge for Candle creek. This was transhipped to the river steamer *Tana*. The spring clean-up on Candle was \$125,000. When the dredge commences the output will be much larger. Conditions in this region are much better, now that larger supplies are available.

ARIZONA

KINGMAN. Near here the Arizona-Butte Mines Co. is doing considerable work. Its Banner mine contains 38,000 tons of ore. To develop the veins in Stockton hill a long adit is to be driven, reaching a depth of 1500 ft. A compressor, engine, and drills have been ordered. The 200-ton mill is nearing completion. It includes a jaw-crusher, rolls, Huntington mill, screens, and concentrating tables, making lead and zinc concentrates. The tailing will eventually be floated.

OATMAN. The new custom mill will be ready to receive ore in about 30 days, the machinery now being overhauled. Water comes from the Big Jim mine.—At 400 ft. in the Big Jim 228 ft. of openings have been made; at 500 ft., 223 ft. of drifts.—At 750 ft. in the Boundary Cone the south drift has cut the vein 130 ft. from the shaft.

STREATOR. In the second quarter of 1916 the Magna Copper Co. produced 2,232,936 lb. of copper, with a profit of \$305,025. The price received was 24.16c. per lb., while costs were 10.47c. Respective figures for the previous term were 2,043,784 lb., \$270,201, 22.39c., and 9.13 cents.

CALIFORNIA

During the 22 years of the operation of the Workmen's Compensation, Insurance, and Safety Act, up to July 1916, there were filed with the Commission 2822 applications for adjustment of controversies over compensation claimed. Of this number of cases the Commission had, up to this date, decided 2407, and of these 94, or slightly less than 4%, had been appealed to the Supreme Court or District Courts of Appeal of this State. In all the others—2313—the decisions of the Commission were accepted by the parties as conclusive of the issues involved.

GOLDSTONE. The 200-ton mill of the Daggett Reduction Co. at Daggett is to be available for ore from the Goldstone district. This should aid lessees considerably.

GRASS VALLEY. More rich ore has been unearthed in the Golden Center mine. This company is also re-opening the Allison Ranch mine, at which unwatering is making steady progress.

OROVILLE. Local men, including P. Reicker, J. M. Chubbuck, G. C. Riley, and others have located 6000 ft. along the middle fork of the Feather river, which they will work by the diving system of mining.

On Slate creek 25 men are constructing a concrete restraining dam for Los Angeles people, who intend hydraulicking at Searles, St. Louis, Howland Flat, Port Wine, and other places.

PRYORVILLE. At the Montezuma mine the shaft is 1000 ft. deep, at which point cross-cutting is being done. Development is under way at 600, 500, and 800 ft. In charge of 25 men is R. Le Fontaine. This old mine is being re-opened by Plymouth Consolidated people.

PRYORVILLE. The following is the statement of output and expenditure for July at the Plymouth Consolidated:

Ore treated, tons,	10,500	Development charge, \$	7,214
Total value,	\$7,300	Surplus,	23,869
Working expenses,	96,217	Other expenditure,	5,256

(Special Correspondence.)—The Argonaut mill is nearing completion. The Kuhl company of Sutter Creek is sub-contractor, a Los Angeles firm being in charge of construction.

The new plant will be equipped with 60 stamps, replacing the 40-stamp mill now in use. The large concrete dam for storing tailing from the new mill is 40 ft. high at the lowest point and 400 ft. long, forming a basin that will hold the waste from this mill for many years, and eliminate present expense and inconvenience. N. S. Kelsey is superintendent of this well-known property, which is one of Amador county's best dividend-payers.

Owing to encountering a cave in the shaft it is said that the work of unwatering the old Eureka has not progressed so well during the past week. A point near the 500-ft. level has been reached, and all efforts are being made to catch up the cave. The plan is to install another pump when the 600-ft. level has been reached, but it is expected that more or less difficulty will be encountered from now on, as it is not expected that the mine could remain full of water for 30 years without causing damage to the shaft.

At the Bunker Hill mill near Amador City a new building, 50 by 80 ft., is to be erected to house new rolls and concentrators. This mine is paying well, but the management realizes the benefits to be derived from modern methods of treatment.

Sutter Creek, August 16.

WOODY. The Weringer Mines Co. has 2 years' ore ready to extract. The 100-ton flotation plant is expected to be in operation within 90 days. High-grade chalcocite was encountered in the 200-ft. level cross-cut. About one car per week of high-grade sulphide is being extracted for shipment. One lot of rich carbonate from the upper levels will be sent to Selby this week. The winze at 200 ft. is down 12 ft. in 4% chalcopyrite, suitable for milling.

COLORADO

LEADVILLE. Exploration of the Down Town property is to begin at once, now that the water in the Penrose shaft is under control.—At the Wolfstone shaft the water is below 1000 ft., leaving 100 ft. to be drained.—For the Mikado shaft on Iron Hill the Colorado Power Co. is constructing two transmission-lines.

MONTEZUMA. At the St. John mine there is 6000 tons of stope-filling on the surface, ready for treatment. This is part of 30,000 tons rendered available by development. A profit of \$2 per ton is expected from this. A stope 400 ft. long is ready for extraction.

OURAY. The Revenue tunnel of the St. John company is completely repaired. The re-modeled mill is soon to be ready, with a capacity of 3000 tons monthly. Copper recoverable from old mill and power-plant is valued at \$25,000.

TELLURIDE. In July the Tomboy Gold Mines made a profit of \$29,240 from 13,000 tons of ore, yielding \$93,500.

IDaho

SALMON. Ten of the 15 stamps at the A. D. M. & R. mill at Gibbonsville are to resume crushing shortly, in charge of E. E. Edwards. A good deal of ore is ready for the plant. — Near the old town of Yellow Jacket a hydraulic hoist is being installed by Burkhardt & Son. Near-by, H. De Prew proposes to add 30 stamps to the Yellow Jacket mill.

MISSOURI

GALENA. Four large mines, the Diplomat, Empire, Portia, and West Virginia are closed on account of the low price of ore. Many smaller ones have suspended since the flood 8 weeks ago.

GRANBY. Cottages for employees are to be built by the American Zinc, Lead & Smelting Company.

JOPLIN. Zinc ore had another slump last week, prices ranging from \$15 to \$65 per ton, basis 60% metal. A fair number of mines are closed. The turn-in of concentrate was the light

est for months. The yield of the district was 3217 tons of blende, 25 tons of calamine, and 622 tons of lead, averaging \$55, \$40, and \$65 per ton, respectively. The total value was \$220,617.

MONTANA

BUTTE. Its third option on 50,000 Bullwhacker shares has been exercised by the East Side syndicate, for \$25,000. Ten cars of ore sent to the East Butte smelter ranged from 4.16 to 8.92% copper.

Work has been started by the Great Butte company at the Bacon property. Boilers and pumps are arriving. A 70-ft. head-frame is to be erected. The Calumet shaft is to be deepened from 1000 to 1500 feet.

GREAT FALLS. At its Rainbow dam on the Missouri river the Montana Power Co. is to increase the capacity of the power-plant by 10,000 kw., at a cost of over \$500,000. The demand for power by Butte mines, the new zinc plant at Great Falls, and the Chicago, Milwaukee & St. Paul line renders this addition necessary. F. M. Kerr is manager, and F. Scotten superintendent. During the first half of 1916 the gross revenue was \$2,903,753, against \$1,910,297 in this period of 1915. The balance for dividends is \$1,551,604, compared with \$789,277.

HARLOWTON. It is expected that the Chicago, Milwaukee & St. Paul Railway will have its line electrified from Harlowton to Avery, Idaho, by October 1.

KENDALL. During the second quarter of 1916 the Barnes-King Development Co.'s revenue totaled \$87,773, \$83,482 of which was bullion from 13,652 tons of ore. The net loss was \$26,157, against a profit of \$26,912 in the first period. The quarter started with a balance of \$184,710, and ended with \$57,414. The Shannon mine work cost \$29,117, and the Kendall \$37,810, including \$30,181 part payment for the property. The North Moccasin mine made a profit of \$12,913, the Piegan-Gloster a loss of \$18,373. No. 2 dividend absorbed \$30,000. In July the North Moccasin yielded \$12,400 from 1622 tons of ore.

LIBBY. Nine miles from Libby the Lukens-Hazel Mining Co.'s development has been rather encouraging. The Buzz Saw claim is the centre of operations. The ore contains gold, silver, and lead.

TRON. Unusual activity prevails in this district, including work at the B. & B. mine of the Snowstorm company, and that of the new L. & U. Mining Co., 9 miles from this place. The L. & U. claims contain lead-silver veins. A 3-mile road is to be constructed to the mine. Spokane people are in control.

NEVADA

ELY. On August 1 the Consolidated Coppermines Co. suspended work, and is now doing nothing, save trying to sell bonds for overhauling the mill.

GOLDFIELD. July returns of the Jumbo Extension amounted to \$28,400 net from 1976 tons of shipping and 808 tons of dump ore. That shipped was worth \$72,500 gross. The Jumbo Extension company has passed its usual quarterly dividend. The following statement was made public: "The cash in bank and ore reserves, in the opinion of the directors, do not warrant the payment of a dividend at this time. No new workable ore has been opened in the mine for the past six months, and the production has come entirely from the ore-shoot first opened 18 months ago. The drain on reserves has been great, and the end of the productive life of the mine is not remote unless further development discloses new orebodies. J. K. Turner's plan of development will require at least \$100,000. It is also the purpose of the company, in order to perpetuate the corporation to acquire a new producing property. One year ago, having the present contingencies in view, the directors adopted a policy of keeping on hand a reserve of \$200,000, and distributing only surplus cash and ore in transit

in dividends, when the necessary amount accrued. The cash in hand and ore in transit do not permit of the distribution of a dividend for this quarter without seriously impairing the reserve and jeopardizing the future of the company."

At the Silver Pick Con. the main shaft is 880 ft. deep, and should soon enter the quartz zone which gave high assays in drill-cores. The Calyx core-drill, working on the 500-ft. level, is down 1100 ft. from the surface. Three promising veins were cut. A heavy flow of water is coming into the shaft.

A large head-frame and 45-hp. electric hoist have been installed at the Grandma shaft, which adjoins the Keweenaw on the east.

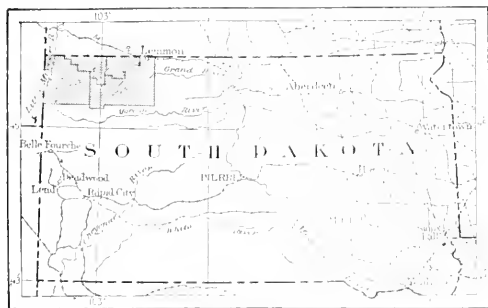
PICOCHE. One hundred miles south-west of here is the Groom district, in which Utah people are interested. The ore is in limestone and shale, containing lead and silver. It is hauled by teams and trucks to Indian on the Salt Lake Route.

SEVEN TROUGHS. It will take 30 days to overhaul the Seven Troughs Coalition mine, which was flooded a week ago by a flow of water below the 1700-ft. level. The water rose to 1500 feet.

TOSOPAH. Last week's output was 9257 tons of ore valued at \$192,706. The Extension mill treated 2200 tons. Development on the Murray vein at 1450 ft. continues excellent.

SOUTH DAKOTA

In Bulletin 627 of the U. S. Geological Survey the lignite field of the north-west of this State is discussed by four of the staff. The area covers 4900 sq. miles in Perkins and Harding counties, north of Deadwood and Lead. Lignite is present in



MAP SHOWING LIGNITE AREAS OF SOUTH DAKOTA.

nearly every part, but mostly in thin lenticular beds. Probably the greater part will never become of more than local economic importance. A few beds are sufficiently thick and persistent to warrant proper development.

TEXAS

(Special Correspondence.)—Henry Bordner and others are preparing to develop a rich cinnabar claim discovered a few months ago, 30 miles north-west of Boquillas. The outcrop is some distance from the Terlingua quicksilver district. It is stated that a 20-ton furnace and other equipment will be installed. Outcrops of cinnabar are found in many parts of the Big Bend district, but so far actual development has been confined to Terlingua and the immediate vicinity.

Boquillas, Aug. 18.

(Special Correspondence.) The Texas Graphite Co. has 75 men employed in developing a large graphite deposit near Burnet. Construction of a 200-ton mill in four units is now under way. A large quantity of graphite ore has already been mined. It contains from 8 to 12% flake graphite. Treatment will be by flotation. The company has spent a considerable sum in erecting residences for its employees and making

other preliminary improvements. The mill product will be shipped to a refining plant in New Jersey.

Burnet, August 18.

UTAH

ALTA. Rails are soon to be laid from Salt Lake City to Alta, and it is expected that the line will be operating before snow falls.

COTTONWOODS. Caterpillar-tractors are pulling 5 to 6 trailers of ore, equal to 30 tons, from Big Cottonwood. Sixty-ton loads were tried, but were too much for one tractor.

According to G. H. Watson of the South Hecla company, prospects for a largely increased tonnage being developed in the Little Cottonwood district were never brighter. There is no comparison between the work being done at present in the district with that of a few years ago. A number of projects now under way will have a vital effect on the production of the district, and it is reasonable to expect important developments in the near future. Diamond-drilling operations by the Emma Copper Co. and the Old Emma Leasing Co. are full of possibilities. Officials of those companies are searching for the continuation of the famous Old Emma orebodies that were cut off by the Montezuma fault. It is easy to understand the importance to the district of the discovery of these orebodies beyond the fault. At the mouth of the Little Cottonwood canyon the Wasatch Mines Co. has three shifts of men at work in preparation for the driving of the long drainage adit. The machinery is installed in the new power-plant, and the miners will be drilling in the near future. The recent consolidation of the Columbus Extension and the Rexall properties and the work now under way, may eventually lead to an outlet on the Little Cottonwood side for the Cardiff ore. It also offers a means for developing the Rexall property at great depth. Numerous companies are operating in the district, and there are more miners employed at present than at any time in the history of the district. Practically all of the work under way is being done along modern scientific lines. The South Hecla company is sending out all of the ore that the smelters will take at present, with good prospects for an increased tonnage later on. The Cardiff is producing ore worth \$120,000 monthly. A dividend of 25c. per share, or \$125,000, is to be paid.

ECREKA. It is understood that the Chief Consolidated is to electrify its plant. Boilers are being repaired at present.

MURRAY. The new 600-ton plant of the Utah Ore Sampling Co. commenced work last week. With the plants at Park City, Tintic, and the other at Murray the total daily sampling capacity is 2100 tons.

PARK CITY. Seven mines here last week shipped a total of 1405 tons of ore. There is increased activity throughout the district. The Keystone is to sink a shaft, working three shifts.

TINTIC. In 31 days at the Homansville mine of the Chief Consolidated the shaft was sunk 256.3 ft., a splendid record. The opening is 6 by 15 ft. in the clear, which has been timbered during sinking. For 150 ft. the shaft was in porphyry, the balance in limestone. Walter Fitch, Jr., was the contractor.

WASHINGTON

CHEWILAH. During the second quarter of 1916 the United Copper company's income was \$83,326, of which \$26,364 was profit. Ore reserves above 1000 ft. are estimated at 320,000 tons, plus 40,000 tons broken in slopes. A new contract has been made with the Consolidated company at Trail as follows: Treatment charge, \$3 per ton on crude ore and \$1 per ton on concentrates. Freight charges on a sliding scale from \$1.25 to \$3.20 per ton, according to value; settlement basis, 95% of the gold value, 90% of the silver value, and 100% of the copper value at 31¢ per pound less than the New York quotations, with 0.3% deduction for slag-loss.

CANADA

BRITISH COLUMBIA

According to R. E. Keith of Joplin, Missouri, recently interviewed at Spokane, this Province has a big future as a zinc producer. While the ores are not similar to those of Joplin, yet somewhat similar treatment should suffice. The Ainsworth and Slocan zinc deposits are very promising.

ONTARIO

COBALT. The Nipissing company has decided to increase its tailing-flotation plant to 500 tons per day.

The Mining Corporation of Canada will soon be refining all of its bullion, instead of shipping concentrate.

MEXICO

NUEVO LEON

(Special Correspondence.)—In the Concepcion del Oro, the Cerralvo, and a number of other mining districts of this part of the country foreign-owned properties are again being operated, after a shut-down of several weeks due to the acute situation that existed between Mexico and the United States. In some instances these mines are still in charge of trustworthy Mexican employees. The Minerals and Metales company, which owns extensive mines at Guadalupe, 50 miles north of Monterrey, recently resumed operations on a larger scale than at any time since the revolutionary troubles began. It is owned by Germans, and this is said to assure the property protection by the de facto Government. Recently large shipments of machinery for the mines and smelter of the company were brought in, and development is to be extended. The company has also imported steel rails and other material for building a spur-track from its mines to a connection with the Monterrey-Laredo division of the National Railways of Mexico.

It is reported here that the American Smelting & Refining Co. will make another effort to operate its plants at Chihuahua, Monterrey, and Aguascalientes as soon as the necessary supplies of coke can be obtained.

Comparatively few Americans have returned to the rich Guanajuato mining district since the general exodus occurred when war between the two countries seemed to be imminent. Conditions in that district are about as bad as could be pictured. Thousands of Mexicans who were thrown out of employment by the closing down of the mines are on the verge of starvation. In the mining districts and cities of the States of San Luis Potosi and Zacatecas this distressing condition exists even to a worse degree than in Guanajuato.

Monterrey, August 17.

KOREA

July results on the Suan Concession of the Scout Mining Co. are given below, and show a good improvement over recent months, particularly when it is considered that half of the Hukol mill—20 stamps, etc.—is still being used for testing purposes on the ore of the huge Sotcharie low-grade deposit of gold, copper, and tungsten. This naturally cuts down the returns from that mill. On the other hand the Tul Mi Chung mill shows a large gain in returns this month and improved extraction. The tungsten ore is proving better than expectations for this experimental work.

Mills worked, average days.....	29
Ore treated, tons.....	17,510
Bullion recovered.....	\$ 29,970
Concentrates.....	119,930
Total recovery.....	149,000
Expense.....	57,500
Operating profit.....	91,500

The complex ore occurs as a mineralized band—8 to 10 ft. wide—of quartzite inter-bedded in limestone.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

M. L. REQUA is examining properties in Alaska.
H. F. ARMSTRONG is with the Weringer Mines Co. at Woody, California.

EDWARD B. DURHAM is now with the Mammoth Copper Co. at Kennett, California.

P. H. CRAWFORD of Divisadero, Salvador, is returning to Palo Alto, California, for a holiday.

S. YASUKAWA, of the Sado mine, Mitsubishi & Co., Japan, is visiting mines in the United States.

H. W. ROSS has been appointed assistant manager for the Backus & Johnston Co. at Casapulca, Peru.

POPE YEATMAN, for several years with the Guggenheim companies, resumes private practice on September 1.

EDWIN S. BERRY will engage in consulting mining engineering after September 15 with offices in New York.

CURTIS F. BURR of Yerington, Nevada, was married on August 5 to Miss Bessie Shields of Hancock, Michigan.

FREDERICK BRADSHAW of the Tonopah Belmont is at its Surf Inlet mine on Princess Royal island, British Columbia.

W. J. ELMENDORF has returned to Seattle from Nevada, and will proceed shortly to the Copper River district, Alaska.

I. KAMIMURA, chief engineer for the Osaruzawa mine, Mitsubishi & Co., Japan, is visiting at Kennett and the oilfields.

ROBERT LIVERMORE, manager of the Kerr Lake mine at Cobalt, has resigned; H. A. KEE of the Nipissing succeeds him.

C. A. RANDALL, mill superintendent for the Tough Oakes company, Ontario, has gone to Cuba to supervise erection of two mills.

WILLIAM B. PHILLIPS has resigned as President of the Colorado School of Mines and returned to professional practice at Austin, Texas.

HOWARD C. PARMELEE, western editor for *Metallurgical and Chemical Engineering* of New York, has been elected president of the Colorado School of Mines.

F. W. TRAPIGEN has resigned as professor of metallurgy in the Colorado School of Mines to accept the presidency of the Colorado Metal Mining & Reduction Company.

T. R. HUNT left London about August 1 for the San Juan Mines property, Rodeo, Argentina, where he is to take charge.

EDWARD THORNTON, superintendent of the Bush-Baxter mine, Twin Buttes, Arizona, has been transferred to Silverbell, as superintendent of the Imperial mine of the American Smelting & Refining Company.

MORTON WEBBER has returned to the practice of his profession after being invalidated for wounds received while fighting with the British forces, and resumes his association with ELLIS P. EABLE of New York City.

W. R. HAMILTON announces that he has withdrawn from the management of Montebello Oil Co. and affiliated companies, to engage in general engineering work in petroleum and metal mining with offices in the Hobart building, San Francisco.

Obituary

C. W. H. KIRCHOFF, of New York, died on July 23 at the age of 63. He was born in San Francisco, and graduated from the School of Mines at Clausthal, Germany. From 1883 to 1906 he was with the U. S. Geological Survey, collecting statistics on copper, lead, and zinc. From 1889 to 1910 he was editor of *The Iron Age*. In the early '80s he was with the *Engineering and Mining Journal*. During his membership of many technical societies, Mr. Kirchhoff was president of the A. I. M. E. He is survived by a wife, brother, and two sisters.

THE METAL MARKET

METAL PRICES

San Francisco, August 22.

Antimony, cents per pound.....	14
Electrolytic copper, cents per pound.....	28.75
Pig lead, cents per pound.....	6.75-8.00
Platinum: soft and hard metal, per ounce.....	\$65-69
Quicksilver: per flask of 75 lb.....	\$72
Spelter, cents per pound.....	11
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, August 22.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$1.00
Chrome: 40% and over, f.o.b. cars California, per ton.....	13.00-16.00
Manganese: 50% product, f.o.b. cars California, ton.....	12.00-16.00
Magnesite: crude, per ton.....	7.00-9.00
Molybdenum: 50% and over, per pound.....	0.60-1.15
Tungsten: 60% WO ₃ , per unit.....	20.00

The tungsten market in Colorado is somewhat better, fair sales of concentrate being reported.

EASTERN METAL MARKET

(By wire from New York.)

August 22.—Copper is higher on account of heavy buying; lead is advancing on better demand; spelter is firm but quiet.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Aug. 16.....	27.00
" 17.....	27.25
" 18.....	27.50
" 19.....	27.75
" 20 Sunday.....	28.00
" 21.....	28.25
" 22.....	28.50

Monthly averages

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	14.21	13.60	21.30	July	13.26	19.09
Feb.	14.46	11.38	26.62	Aug.	12.34	17.27
Mar.	14.11	14.80	26.65	Sept.	12.02	17.69
Apr.	11.19	16.64	28.92	Oct.	11.10	17.90
May	13.97	18.71	29.02	Nov.	11.75	18.88
June	13.69	19.75	27.47	Dec.	12.75	20.67

Copper Range is paying \$2.50, and Champion \$6.10 per share. The latter has paid \$37 per share this year.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Aug. 16.....	66.50
" 17.....	66.25
" 18.....	65.75
" 19.....	65.75
" 20 Sunday.....	65.75
" 21.....	66.00
" 22.....	66.75

Monthly averages

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	67.58	48.85	56.76	July	54.90	47.52
Feb.	67.33	18.45	56.71	Aug.	54.25	47.11
Mar.	58.91	50.61	57.39	Sept.	52.75	48.77
Apr.	58.52	50.25	61.37	Oct.	51.12	49.10
May	58.21	19.87	74.27	Nov.	49.12	51.88
June	56.13	19.03	65.01	Dec.	49.27	55.34

The tendency of prices has been somewhat erratic during the current week. The latest London advice states that on several occasions rather heavy sales have been made attributed to state banks and other exceptional sources. When Eastern rates are discounting buyers hang back, knowing that the market lies in their hands, but when rates are added steady they are only too glad to take whatever offer. America has been selling less freely. The silver reserve in the Indian treasuries continue to increase, but as in preceding weeks the total of the note issues is enlarged to about the same extent. Exports

of silver from London to India to August 2 amount to 11,427,500, compared with \$2,955,000 in this period of 1915. The good demand for coinage still continues, while there has also been some inquiry on speculative account, the moderate supplies being easily absorbed. The Indian Bazaars still seem to consider that the present level of prices is high enough, for, although purchases have been made for that quarter, sales on that account have predominated. This increase of the Indian bear account should prove a factor for strength later on, as the amount now open is by no means a negligible quantity, while the demand for coinage should prevent any weakness in the near future, although China exchanges are still lagging behind.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Aug. 16.....	6.00
" 17.....	6.10
" 18.....	6.25
" 19.....	6.50
" 20 Sunday.....	6.50
" 21.....	6.75
" 22.....	6.60

Monthly averages

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67
Mar.	3.94	4.04	7.26	Sept.	3.82	4.62
Apr.	3.86	4.21	7.50	Oct.	3.60	4.05
May	3.90	4.24	7.38	Nov.	3.68	5.15
June	3.90	5.75	6.88	Dec.	3.80	5.34

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Aug. 16.....	9.00
" 17.....	9.25
" 18.....	9.50
" 19.....	9.50
" 20 Sunday.....	9.50
" 21.....	9.60
" 22.....	9.75

Monthly averages

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17
Mar.	5.12	8.40	18.40	Sept.	5.16	14.14
Apr.	4.88	9.78	18.62	Oct.	4.75	14.05
May	4.91	17.03	16.01	Nov.	5.01	17.20
June	4.84	22.20	12.85	Dec.	5.40	16.75

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
Aug. 16.....	80.00
Aug. 17.....	80.00
Aug. 18.....	80.00
Aug. 19.....	80.00
Aug. 20.....	80.00
Aug. 21.....	80.00
Aug. 22.....	80.00

Monthly averages

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	39.25	51.90	122.00	Aug.	37.50	95.00
Feb.	39.00	60.00	125.00	Sept.	37.50	93.75
Mar.	39.00	75.00	130.00	Oct.	37.50	91.00
Apr.	39.00	75.00	130.00	Nov.	37.50	92.90
May	39.00	75.00	130.00	Dec.	37.50	91.00
June	39.00	75.00	130.00			

TIN

Prices in New York, in cents per pound.

1914.	1915.	1916.	July	1914.	1915.	1916.
Jan.	37.85	34.10	41.76	July	31.60	37.28
Feb.	39.76	37.23	42.60	Aug.	31.60	37.28
Mar.	38.10	48.76	50.30	Sept.	31.60	37.28
Apr.	36.10	48.25	51.19	Oct.	31.60	37.28
May	33.29	39.28	49.10	Nov.	31.60	37.28
June	30.75	40.26	42.07	Dec.	31.60	37.28

Tin is steady at 35.25 to 35.35 cents.

Eastern Metal Market

New York, August 16.

Practically all the metals show an improvement in prices and tone.

Copper is stronger and more active and second-hand metal has practically disappeared. The probable foreign purchases dominate the situation.

Zinc is higher, with demand from foreign and domestic consumers increasing rapidly.

Tin is advancing on fair sales with inquiry considerably better.

Lead is stronger and the price slightly higher.

Antimony is again rising after a decline to a point regarded as the bottom.

Aluminum continues firm.

Domestic buying of steel has developed to an extent not seen in weeks. This comes as a result of large War and other export orders recently placed. Estimates put the total number of large shells ordered in the last two weeks at 3,000,000, besides 500,000 tons of shell-steel has now been ordered by the Allies. Pig-iron is brighter, with signs that a buying movement, expected in September, has already started.

COPPER

Some brokers are of the decided opinion that the copper market is stronger than at any previous time. It is true that inquiry for both foreign and domestic account has broadened extensively. The market has been full of rumors of the probable purchase by various foreign governments of large quantities of copper, estimates of their needs running from 250,000,000 to 350,000,000 lb. Some regard this as largely talk, as so far prices have failed to advance to any extent. Others report a good business having been done in both foreign and domestic. Inquiries from domestic consumers have been stimulated by the prospective foreign purchases, because of the desire to anticipate this buying. In some quarters it is the opinion that force has been attempted by these rumors to bolster-up prices. At any rate the whole tone is stronger and better, and there is no evidence of weakness anywhere. The quotation for spot at this writing is 27c. cash, New York, with last-quarter metal obtainable at 26 to 26½c. It is reported there is little near-by copper available. The London quotation yesterday was £126, compared with £124 a week ago. Exports in 16 days were 13,456 tons. Lake copper is nominal at 26.75c. cash. One broker considers that already at least 125,000,000 lb. of the prospective foreign needs has been negotiated for 1917 delivery, the sales being apportioned among large producers by the American Smelting & Refining Co. as the chief distributor. A rumor that the Central Powers were also purchasers or inquirers cannot be substantiated. Any purchases they might make would be for delivery after the War.

ZINC

A decided change has come over the market and demand yesterday was reported, at least by one broker, as more active than at any time in several months. He characterized the tone as unusually strong. Inquiries were numerous in lots of 250 to 1000 tons, and some good business was done. The demand comes not only from foreign sources, but also from domestic consumers, among whom are the brass mills and especially the galvanizers, who are regarded as about to cover for fourth-quarter needs. Prices have been advancing during the past week until yesterday spot metal at New York was quoted at 9c., and 8.75c. at St. Louis. One broker said he turned-down an inquiry for 1000 tons at 9c. yesterday. For last quarter 8.25 to 8.50c., New York, is asked. The demand has been for

both near-by and fourth-quarter delivery. Exports so far this month, including yesterday, were 2649 tons. Sheet zinc is still 15c. for carload lots f.o.b. smelter, 8½ off for cash.

LEAD

The market is stronger and demand is better, a spurt having manifested itself early this week. The entire tone is strong and prices are a little higher. The quotation today is 6c., New York, and 5.90c., St. Louis. Inquiry is increasing from both foreign and domestic sources, and some good sales are reported. The independents have been recently under-selling the leading interest, but yesterday their price had nearly reached the latter's. Exports this month, up to and including yesterday, were 75½ tons compared with 429 tons a week ago. The London market yesterday was £30 for spot and £29 15s. for futures. The tone of the market is much less pessimistic.

TIN

There has been more interest in the market in the past week and the feeling is better. Some sellers reported a good demand at one time, while others at the same period took a contrary view. This attitude was later reversed by both parties so that the market has presented a queer aspect. But a decided improvement is certain and there have been substantial inquiries and some fair sales. On the 9th there was a good demand for Banca tin with a fair quantity sold, as well as some Straits tin for Eastern shipment—probably 200 to 250 tons in all. The market was quieter on the 10th with inquiry fair but apparently no sales. The next day, however, it developed that at least 225 tons had been sold on the 10th. On the 11th dullness appeared but late that day a boom started resulting in sales of over 200 tons. Saturday inquiry was good and more tin could have been sold had there been more sellers, but at least 100 to 150 tons changed hands. This week there have been moderate sales, mostly for spot, August and September delivery. Yesterday the market was again dull with spot Straits quoted at 39c., New York, against 39½c. the day previous. Arrivals up to August 16 total 2497 tons, with 3135 tons afloat.

ANTIMONY

It is believed that the bottom of the decline was reached when Asiatic grades sold as low as 9½c. last week, duty paid. A turn has recently been evident with a much better demand and some business done with Canada. Yesterday the metal had advanced to 10 to 10½c. duty paid. In all, several hundred tons are said to have changed hands. There is little business in needle antimony at 8 to 8½c. per pound.

ALUMINUM

The market is firm at 59 to 60½c. per lb., for No. 1 virgin metal, 98 to 99½ pure. A month ago 60c. was asked, and one year ago it sold as low as 31c. The high price for 1916 thus far has been 65c., with 41c. as the low.

ORES

Antimony: There has been practically no business during the past week, the last sale of small lots having brought \$1.10 to \$1.20 per unit.

Tungsten: This ore is nominally \$20 to \$25 per unit, but the prospect for a higher market is brighter. The foreign demand is a dominating factor, and considerable quantities have been sold recently to foreign countries thus diverting shipments from the United States and absorbing some of our stocks. In addition, on July 19 Japan prohibited the exports of tungsten and molybdenum except under license. These facts tend to a more steady market.

Company Reports

CHINO COPPER CO.

Reports covering the second quarter of 1916 are as under:

Overburden removed, cubic yards	871,138
Ore treated, tons	788,500
Average metal-content, per cent	1.79
Copper production, pounds (including precipitate).....	18,157,923
Average price received, cents per pound	27.49
Cost, cents per pound	8.89
Profit	\$3,221,969
Dividends paid	1,957,455
Surplus	1,264,514

The monthly yield was 610,000 lb. more than in the previous period, when the price was 26.57c. per pound. While the profit was \$470,000 more, the surplus is \$400,000 less, after paying an increased amount of dividend, \$770,000. The mill is to be improved to treat oxidized ore and tailing.

UTAH COPPER CO.

During the period construction started on additions to the mills and for the new leaching plant. The former work will increase their capacities and recoveries.

Overburden removed, cubic yards	1,659,594
Ore treated, tons (a record).....	2,758,500
Average grade, per cent.....	1.381
Recovery, per cent	63.51
Copper production, pounds (a record).....	48,384,929
Cost, cents per pound	6.726
Profit, including dividends received, etc.....	\$9,958,317
Price received, cents per pound.....	26.758
Dividends paid	4,873,470
Surplus	5,084,847

RAY CONSOLIDATED COPPER CO.

Development, feet	16,217
Cost of mining and coarse crushing, cents per ton....	80.85
Ore treated, tons	865,300
Average content, per cent	1.631
Cost of treatment, cents per ton.....	51.41
Copper production, pounds (with crude ore smelted).....	19,171,238
Cost, cents per pound	10.507
Profit	\$3,242,542
Dividends	788,590
Surplus	2,453,952

Over 110,000 tons more was treated, the yield was 3,300,000 lb. greater, the profit was an increase of \$1,000,000 and the surplus \$1,000,000 more than in the first quarter. Dividends were practically the same.

The profit was almost \$3,000,000 larger than in the March quarter. There was no unsold copper on hand at the end of the term. Costs were lowered 0.251c. per pound. The surplus shows a gain of over \$2,000,000.

BUTTE & SUPERIOR MINING CO.

In the second quarter spelter averaged 11.11c. per pound, in the first 16.1052c.; the total net profit was \$292,029, against \$555,510, a large decrease due to low metal prices. Dividends absorbed \$10.75 per share. Net quick assets are \$3,300,000, an increase of over \$300,000. Sales of spelter for future delivery have been made, covering a good proportion of production in the remainder of 1916.

At the mine a great deal of shaft work was done. Development commenced at 1700 and 1800 ft., where as far as opened, the character of the orebodies is as favorable as in the levels

above. Reserves increased 30% above the quantity extracted. Work beyond the Black Rock claim was especially gratifying. The cost of mining was \$4.971, an increase of 46.3 cents.

Mill results were as follows:

Ore treated, tons	161,270
Zinc-content, per cent	15.9709
Silver-content, ounces	6.7041
Zinc-content of concentrate, per cent.....	52.9956
Silver-content of concentrate, ounces.....	21.8757
Zinc in concentrate, pounds.....	47,901,445
Recovery, per cent	92.989
Cost of treatment, per ton	\$1.761

Milling results generally were almost the same as in the previous term, although costs were 18.47c. higher. All costs were \$6.2581, against \$5.6104 per ton.

NEVADA CONSOLIDATED COPPER CO.

Ore treated, tons (12% from underground).....	1,094,879
Metal-content, per cent	1.57
Copper production, pounds	24,091,021
Price received, cents per pound.....	27.23
Cost, cents per pound	8.51
Earnings	\$4,853,945
Dividends	1,499,593
Surplus after depreciation and ore extinguishment.....	3,059,917

Comparing with the previous quarter there was 167,999 tons more treated, the output was a gain of 4,930,747 lb.; and the price was 1.66c. per pound higher.

Recent Publications

TERTIARY FAUNAL HORIZONS OF WESTERN WASHINGTON. By Charles E. Weaver. P. 67. Plates. University of Washington, Seattle, 1916.

MINING IN NORTHERN ONTARIO. By Arthur A. Cole. P. 72. Ill., index. Temiskaming and Northern Railway Commission, Toronto, 1916.

SOURCES OF NITROGEN COMPOUNDS IN THE UNITED STATES. By Chester G. Gilbert. P. 12. Published by the Smithsonian Institution, Washington, D. C., 1916.

INVESTIGATION OF THE PEAT Bogs AND PEAT INDUSTRY OF CANADA, 1913-'11. By Aleph Abrep. Bulletin 11. P. 185. Ill., maps, index. Department of Mines, Ottawa, 1915.

STRENGTH OF WELDS OF I-BEAMS AND GIRDERS. By H. F. Moore and W. M. Wilson. Bulletin 86. P. 59. Illustrated. University of Illinois Engineering Experiment Station, Urbana, 1916.

ARGENTINE RAILWAYS. A review of their position, conditions, and prospects. By Leopold Grahame. P. 36. Illustrated. Rensselaer, Lyon & Co., New York, 1916. A map would have improved this interesting booklet.

STRENGTH AND OTHER PROPERTIES OF CONCRETES AS AFFECTED BY MATERIALS AND METHODS OF PREPARATION. By R. J. Wig, G. M. Williams, and E. R. Gates. Technological paper 58. P. 172. Illustrated. Bureau of Standards, Washington, D. C., 1916. It includes the results of about 20,000 tests on 300 aggregates consisting of limestone, granite, gravel, and trap-rock which are used for concrete materials in various parts of the United States. The conclusions are of especial interest to contractors, engineers, architects, and others who use concrete, since it points out that with the same aggregates a variation in strength of as much as 100% may result owing to the lack of proper precautions in mixing and placing the material.

EDITORIAL

T. A. RICKARD, Editor

THE metal market is better than for some time past, and readers will find our New York letter this week worthy of attention. The lead situation is interesting.

ANTIMONY miners and smelters have experienced a dull time lately, the price of their product dropping from 45 cents to 9 cents, and at the latter figure the metal was almost unsaleable. The market is now much stronger in tone, with an advance to 14 cents, as a consequence of under-estimation of stocks by the trade, renewed buying, and considerable sales for munitions' purposes.

INCREASED wages are asked by miners of Amador county, California, on account of the high cost of living. The men receive from \$2.75 to \$3.25 per shift, which includes a 25-cent raise granted some time ago. Now they speak of an additional 50 cents per day. The mine-owners say that this cannot be given, as the cost of supplies has increased so much. There is quite enough labor unrest in the country at present, and it is to be hoped that this latest dispute will be settled amicably.

RECENTLY we commented on the Calumet & Hecla semi-centenary. The president, Rodolphe L. Agassiz, has given some interesting figures to the *Boston News Bureau* regarding 50 years of operation. The copper output was 2,686,896,000 pounds, equal to 1,343,448 tons. Dividends amounted to \$132,250,000. The most significant feature—and one that might be profitably noted by the Western Federation of Miners, now the International Union of Miners, Mill, and Smelter Men, is the amount paid in wages, namely, \$129,230,938, nearly equal to the dividends.

FLOTATION is elucidated in this issue by Mr. Will H. Coghill. He offers an analysis of the molecular forces that are at the back of the curious phenomena of frothing. While some of our readers may prefer a description of the application of the process in a mill, it is certain that our methods of concentration by flotation will not improve until we get a firm grip on the essential principles of the physics involved. This is being recognized by the mining companies. Even if they have not sent members of their staff to engage in research work in university laboratories, they have, we believe, in several instances commissioned metallurgists to make special investigations. The better-equipped mines have laboratories in which a great deal of research work is being done and we would only venture to suggest that

those doing such work should be given a chance to collaborate with physicists. The metallurgist must approach the fundamentals of flotation from the physical, not the chemical, side. There he is weak admittedly. In the same way the study of flotation in mining-schools is left too much to the metallurgical department, aided by the chemical, ignoring the fact that the strange features of the process can be explained only in terms of physics. His writing on the subject, in this issue, will well repay careful study, for he has the scientific spirit, which never rests until it gets at the truth. Comments or criticisms on his article will be deemed a compliment by him and by us.

IN our issue of April 8, 1916, we gave some particulars of the smelter to be erected at Kellogg, Idaho, by the Bunker Hill & Sullivan company. We note with pleasure that on August 19 the beginning of actual construction was duly celebrated by the company, its employees, and citizens of Kellogg. A feature of the proceedings was the presentation of several bars of lead by the general manager, Mr. Stanley A. Easton, to public institutions, these bars being the first made in the Coeur d'Alene. We hope that our next announcement concerning this smelter will chronicle the blowing-in of the furnaces.

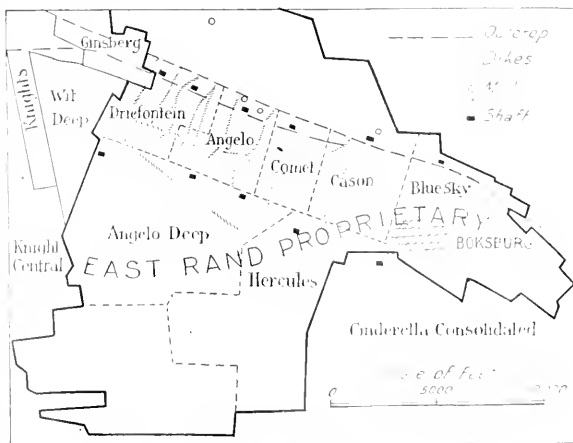
BOLIVIA has come to the front in tungsten production during the past two years. In the first three months of 1916 there was exported—75% to the United States and 25% to Europe—608 tons of wolfram, containing 65% tungstic acid. This does not indicate the production, as it is said that considerable quantities of ore are being stored until the end of the War. Of the output, 69% comes from Oruro, 19% from La Paz, the remainder from Potosi, all well-known centres in connection with the tin industry. During the whole of 1915 wolfram exports were only 625 tons. The antimony yield is also gaining in importance. In the first quarter exports amounted to 7191 tons of high-grade ore valued at \$1,500,000, as against 509 tons in the same period of 1915. Regarding wolfram it may be added that two years ago only two companies were extracting this mineral; now there are over two hundred.

TUNGSTEN producers, especially those in Colorado, are optimistic regarding an early rise in price, now \$10 to \$20 per unit for 60% concentrate. New war contracts necessitate more high-speed tool-steel. The foreign demand is increasing, and shipments from South

actual performance during the ensuing decade, we should have a body of evidence of the greatest value to the engineers engaged today in making similar appraisements. But reports on mines constitute a kind of literature that few people take the trouble to preserve. Therefore we lose the benefit of much useful information. However, here we have some examples. Nine years ago a detached onlooker of some experience in these matters undertook to prepare a list of the principal gold mines. Let us see what happened. In that list there were five South African mines. Of these, the Cason is now a part of the East Rand Proprietary, a consolidation that became the victim of a fiasco in 1911, when a depreciation of \$30,000,000 in the market-value of the property took place within a few months, followed by a further depreciation of \$17,750,000 in the three ensuing years, so that shares quoted as £5½ sank to £1½ on a capital of 2,445,897 shares, indicating a loss of over \$50,000,000. It was proved that the capacity of the mine had been hugely over-rated, the mill-returns had been juggled, and a number of relatively worthless properties had been included within the consolidation in order to enable their owners to realize upon them at the expense of the public. From that shock the South African market has scarcely recovered yet. The Cason, which in 1907 was earning a profit of \$174,000 (£1 being taken at \$4.85) monthly from an output of 36,500 tons, in 1915 averaged a profit of \$265,115 from 165,300 tons monthly. Thus the tonnage was more than quadrupled, while the profit increased to about one-third more than it was nine years earlier. The grade of ore declined from \$10.31 to \$6.25 per ton, while the cost decreased only from \$5.51 to \$4.75, despite the enormous growth of tonnage. It is evident that the Cason has proved a disappointment, although on the whole it has done better than some of the other mines included in the East Rand Proprietary. The next mine on the select list was the Simmer & Jack, which, in 1907, was treating much the largest tonnage of any mine on the Rand. In that year its monthly average was 62,200 tons, yielding \$505,500 gross, and \$226,000 in profit on \$8.12 ore. During the year ended June 30, 1915, the mill treated 68,122 tons monthly for a gross yield of \$350,250 and a profit of \$133,600 on ore averaging \$5.34 per ton. Here again the tonnage has been increased, but not much, while the yield and the profit have fallen considerably. The mine is nearing its end, having only 2,428,000 tons remaining, or enough ore to last three years. It has fulfilled expectations fairly well. These mines on the Rand have no extra-lateral right, so that their future prospects are delimited by the side-line. When an 'outcrop' mine, that is, one located so as to cover the outcrop of the gold-bearing beds of conglomerate, or 'banket,' is worked out on the dip up to a line vertically under its surface boundary on that side, it has to stop: the property owning the ground covering the continuation of the lode on its dip is called the 'deep level.' This is the relation of the Simmer & Jack to

the Simmer Deep, of the Robinson to the Robinson Deep, of the Village Main Reef to the Village Deep, for example. The lack of apex-rights limits the future prospects of an 'outcrop' mine, but the existence, below its ultimate bottom, of workings due to the operation of the corresponding 'deep level' mine serves to sample the ground, so that the resources of the property are ascertainable with a completeness comparable to the appraisal of an alluvial area that has been carefully drilled.

Next we come to the Robinson, which is among the great mines that have made good. At the beginning of 1907 the output was 31,100 tons monthly, yielding \$438,500 gross, and a profit of \$286,000, on an ore averaging \$14.10 per ton. In 1915 the average output was 57,400 tons, yielding \$387,690 gross, and a profit of \$198,225 monthly, on ore averaging \$7 per ton. The grade has been lowered to one-half what it was and the cost has been reduced from \$4.90 to \$3.40 per ton, so that with a tonnage nearly doubled, the profit is 30% less. This decline in profit has been marked only in the last two or three years. The Robinson is now nearly exhausted, but it has fulfilled its promise handsomely, as we shall see on further analysis later. The Robinson Deep, which follows the Robinson on the dip of the banket, was producing 38,800 tons monthly in 1907, yielding gold worth \$414,000, and a profit of \$209,000 on ore averaging \$10.68 per ton. During the year ended July 31, 1915, the average monthly output was 50,583 tons, yielding \$348,784, of which \$125,388 was profit, on ore averaging \$6.80 per ton. In this case also the resources of the mine are near an end,



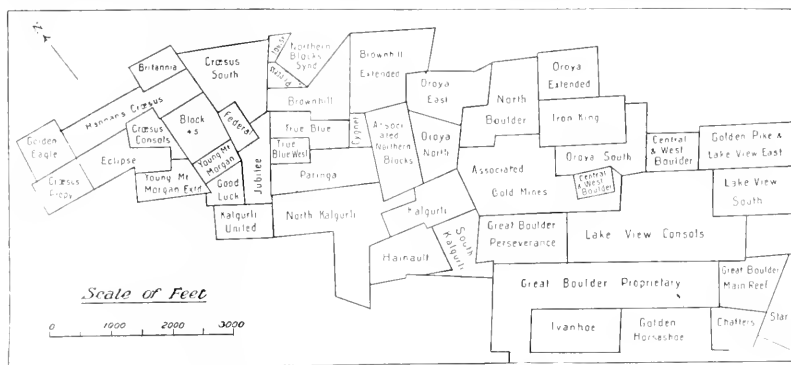
THE EAST RAND PROPRIETARY.

the ore assured amounting to 1,787,000 tons averaging \$6 per ton, or enough for three years only, with no chance of further discovery. The fifth South African mine cited by us in 1907 was the Village Main Reef, which at that time was producing 37,100 tons monthly for a gross yield of \$315,000 and a profit of \$119,000 on ore averaging \$8.50 per ton. During 1914 and 1915 the mine suffered from 'air-blasts' or settlements of rock, caus-

companies, the 'profit' is a mere bit of book-keeping, the real gain, as measured in dividends, being considerably less. In 1915 the 'profit' was £473,443, while the dividends amounted to £335,500. From September 1884 to the end of 1915 the Mysore mine produced 4,525,871 tons of ore, yielding \$82,743,891 in gold, and paid dividends aggregating \$39,287,961. The Champion Reef, which adjoins the Mysore and exploits the same lode on the downward pitch of the ore-shoots, was producing 16,730 tons of \$12 ore in 1907, winning \$202,000 gross and \$65,000 profit monthly. In 1915 the average output was 17,614 tons of \$11.45 ore, including yield from tailing, making \$220,040 gross and \$84,875 profit monthly. Evidently the ore has maintained its grade, while the cost has been reduced from \$7.66 to \$7.04 per ton. The increase of tonnage and decrease of cost have enabled the company to increase its dividends. In 1907 the total yield

has come an inglorious smash. In the summer of 1910 the shares, which had stood at £10½, began to fall on rumors from New Zealand. As a matter of fact, the contraction of the orebodies below the zone of oxidation became apparent in 1909. In August 1910 the Geological Survey of New Zealand began a study of the district, eliciting information unfavorable to the future of the mine. But the information was not given to the shareholders, so that the news came suddenly and disastrously in 1911. The ore in reserve at the end of 1915 was stated as 806,000 tons, besides 673,900 tons in pillars and remnants, so that the mine has a life of seven or eight years, at least, and some chances, slender, it is true, of rehabilitation. The output of gold and silver to the end of 1915 is \$53,904,937 from 4,790,403 tons, of which \$24,755,525 was distributed in dividends.

The great bonanza in the Esperanza did not last long.



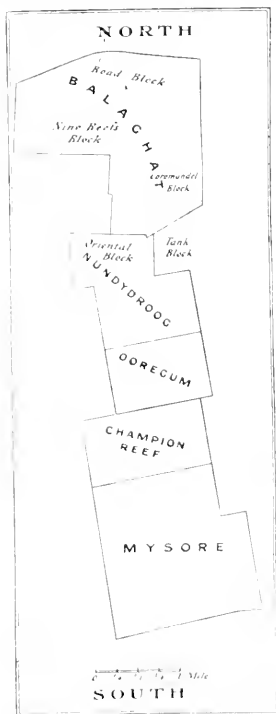
MAP OF GOLD-MINING PROPERTIES AT KALGOOLIE.

was £500,189 and the dividends £104,000; in 1915 the yield was £545,338 and the dividends £147,333. From 1892 to the end of 1915 this mine has produced 3,607,487 tons, yielding \$58,464,375 in gold and \$20,879,085 in dividends. The ore-shoots have a pitch of about 45° southward, so that the question of downward persistence is determined for the Mysore by the evidence obtainable in the Champion Reef ground. The latter did handsomely until about 11 years ago, when it had attained a depth of 3700 feet. In 1905 the dividends were £416,000. Since then the length of stoping ground has contracted. The greatest vertical depth attained on this lode is 4670 feet, in the Oregon mine, south of the Champion Reef, which itself has a shaft 4340 feet deep. The Mysore is down to 3465 feet vertically, or 5000 feet on the dip of the lode. These mines are still to be ranked among the big fellows, but they exhibit signs of impoverishment, and the value of their reserves is not known owing to the fact that the managers state the tonnage of ore assured but they do not state the average gold contents of it. However, they have made a splendid record, they have been wisely administered, and the statistical evidence proves that they were properly classed among the great producers of gold.

The Waihi, which ranked among the very best in 1907,

although the mine has continued to be productive. This property, at El Oro, Mexico, came into sudden prominence in 1904, the shares jumping early in 1905 from \$5 to \$30. Three years later the rich ore had been worked out, but since then more ore of medium grade has been found by intelligent exploration. It is doubtful whether the Esperanza should have been included in the list of the great gold mines; it yielded one of the most remarkable orebodies and made a spectacular production for a short time, but it never had the assurance of continued richly productive life such as characterizes the mines of the very first rank. In 1906 this mine produced 150,047 tons, yielding \$4,548,975, out of which \$3,420,162 was paid in dividends. The ratio of gold to silver, in value, in the ore is as 4:1. The total production from October 1903 to the end of 1915 has been 2,085,936 metric tons, yielding \$36,172,019, from which dividends of \$11,971,620 have been paid. In 1914 the output was 120,975 tons, which, with the re-treatment of 45,237 tons of tailing, yielded \$1,039,698, of which \$402,426 was profit. So it is evident that the mine is still a notable producer. In 1915 operations were crippled by the Mexican revolution. Ore reserves are estimated at 156,000 tons, containing a profit of \$532,000, or enough for over a year.

Two American mines were included in the list; of these the Camp Bird is practically exhausted, unless the unexpected happens and new orebodies are found by the deep adit now being driven far below the existing workings. Even in 1907 it was known that the showing in depth was poor and that future production depended chiefly on lateral development. But the Camp Bird has done well. From April 30, 1903, to June 30, 1915, it produced 795,129 tons yielding \$22,152,297, or \$27.86 per ton. The profit distributed had been \$14,427,090, to which must be added the \$1,500,000 used in the purchase of the Santa Gertrudis, which is controlled by the Camp



THE INDIAN MINES.

Bird company. The mine was discovered in 1896 and yielded \$4,035,500 gross and \$2,100,000 profit to Thomas F. Walsh before it was sold to the English company, so that altogether it has yielded \$26,187,797 gross and \$18,327,000 in actual profit. The Camp Bird has done all that was expected of it and a good deal more. The shares were never kited, so that the public had a good run for the money put into this mine. The Homestake is doing just as well as nine years ago. It has proved a wonderful mine. In 1907 the monthly output was 120,250 tons of \$3.85 ore, yielding \$154,000 gross and \$135,000 net, at a cost of \$2.73 per ton. Now the average output is 131,000 tons of \$4.08 ore, yielding \$535,750 gross and \$184,181 net, at a cost of \$2.65 per ton. By supplying 10,000 tons more monthly to the mill, the cost has been reduced

while the yield has been more than maintained. In 1914 the yield was \$3.88 and the cost \$2.89. The dividends paid during the calendar year 1915 amounted to \$2,210,208 as compared with \$1,201,200 in the year ended May 30, 1907. The company's fiscal year has been changed. This mine therefore is doing almost twice as well, in terms of dividends, as it was nine years ago. What ore is in reserve is not stated.

Next we come to the Mount Morgan, in Queensland. This mine has become increasingly important as a source of copper, the ore averaging 2.6% copper, worth (at 17 cents) \$8.84, and 7.7 dwt. gold, worth \$7.70. In the half-year ended May 28, 1916, the Mount Morgan produced 208,676 tons of ore yielding 3997 tons of copper and 57,352 ounces of gold, together worth \$2,930,000, equivalent to 34,780 tons and \$488,300 monthly. The surplus was \$858,450, or \$143,075 per month. This compares with 26,275 tons, \$404,000 gross, and \$147,500 profit per month at the beginning of 1907. In the latter half of 1906 the output of copper was only 1751 tons of blister and 172 tons of precipitate, and the total revenue in that period was \$2,173,482. The yield in copper and gold is \$13.65 now as compared with \$15.36 then. Evidently this mine is still going strong. The control passed into new and capable hands in 1913, when a purchase of 350,000 shares (out of 1,000,000) for \$6,250,000 marked the withdrawal of the Hall family out of this enterprise. The profit had been disproportionate to the gross output and the management had lacked initiative. Since then the plant has been re-modeled. From 1882 to November 30, 1915, this great ore deposit had yielded 4,147,000 ounces of gold, worth \$85,335,750 and 65,600 tons of copper, worth \$18,973,200, or a total of \$104,309,950, from which \$40,396,455 has been paid in dividends. Production of copper began in 1906. In 1911 the Many Peaks mine was purchased as a source of low-grade pyrite suitable for mixing with the silicious ore of the Mount Morgan deposit. Chlorination was abandoned shortly thereafter in favor of matte-smelting. At the end of 1915 the ore reserve was estimated at 1,000,000 tons, averaging 3½% copper and 9.81 dwt. gold, 2,930,000 tons averaging 2.42% copper and 5 dwt. gold, also 496,000 tons of 1.19 to 2.46% copper and 6.9 to 1.02 dwt. gold per ton.

Summarizing the performances of these 16 mines during the 9 years, it is apparent that four proved sad and expensive fiascos, owing to human frailty rather than geologic perversity; twelve justified the estimates formed of them by competent engineers, and of these twelve, five still hold their rank among the great producers of gold. Four, possibly five, out of the sixteen were given so inflated a value on the share-market that they were the cause of large loss to the public. Allowing for these examples of over-valuation, aided by chicanery on the part of market-operators posing as trustees for the shareholders, it is evident nevertheless that these rich mines have been the basis for a wonderfully profitable business.

In a later article we shall discuss the question: Which is the greatest gold mine in the world?

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor reserves expressions of views contrary to his own, believing that careful criticism is more valuable than casual complacency.

Gyratory Crushers

The Editor:

Sir—Owing to the fact that repairs cause a large reduction in the profits of every rock-crushing plant, I believe the following will be of interest to some of your readers. I have had a great deal of trouble with gyratory rock-crushers due to breaking. A crusher which has the bowl and bottom spider cast in one piece, often breaks in the spider from contraction and expansion. I hit upon the plan of having the spider cut out and a new one cast of steel, with the legs larger than the old one and made with a shoulder that projects below the rim of the bowl. After having both bowl and legs milled smooth, the spider is pressed into place and fastened with four 1½-inch stud-bolts in each leg.

I now have in use three crushers that have been repaired in this manner and they seem better than new ones. The bowls of this size cost about \$600 at the factory while the repairs cost about \$150.

LEE DAVENPORT.

Portland, Oregon, August 5.

Postage to South America

The Editor:

Sir—Your editorial of June 17, discussing deficient postage to foreign countries, should have been printed in 'box-car letters,' and I would like to stamp it at the bottom of every letter that I write to the United States.

Since my arrival in Chile five months ago, about one-half of the first-class mail that has come to me from the United States has been held up at the local post-office and fined for lack of sufficient stamps. This apparent ignorance of postal regulations affecting foreign countries is inexcusable. I am reliably informed that the 'frank' privileges of the U. S. government does not extend to South America.

If the people in the United States expect to permanently increase their business with South America, they should give serious heed to your advice, and do all possible to avoid these little but intensely irritable faults. If it makes a loyal American citizen hot to have a large proportion of his mail materially delayed, and to have to pay a money fine for such carelessness, it is not to be expected that our South American friends will be more tolerant. As a matter of fact, I believe that such little things cut a good deal more figure in our daily business dealings than we realize, and that persistent failure in

attention to small details has a decided bearing on our estimates of the people with whom we deal.

LOUIS A. WRIGHT.

Santiago, Chile, July 13.

Surficial Indications of Copper

The Editor:

Sir—One or two points occur to me in connection with Mr. Probert's interesting articles that may be worth mentioning. His opinion on the possibility of guessing at the probable copper-content of primary ore from the color and consistence of the surface iron stain and of the gossan would be valuable. Has Mr. Probert found that a dark, rich, golden-oak or mahogany-colored surface stain usually indicates that the primary ore was fairly rich in copper, while a lighter yellow or bright-red stain indicates that the primary ore was lean in copper, requiring great enrichment to form commercial ore? Also I should like to know whether, unlike most of us, Mr. Probert has any explanation for this coincidence.

In his third article, Mr. Probert speaks of a sandy, granular pyrite in the Briggs mine here, associated with enriched chalcocite ore. While there is a lot of this sandy pyrite with limonite seams and stains, it is by no means a certain indication of ore. Apparently when well-formed pyrite crystals are cemented by finer grained, less crystallized pyrite, part oxidation will cause an iron-stained pyrite sand similar to that which is formed when the cementing material between the pyrite grains consists largely of copper sulphides.

IRA B. JORALEMON.

Warren, Arizona, August 15.

Prospecting

The Editor:

Sir—In the issue of July 22, Harold French outlined a scheme for co-operative prospecting, which requires the combined capital of 20 investors and the efforts of several skilled prospectors under the direction of a mining engineer. In the issue of August 12, John B. Platts throws cold water on the plan and says that it would not succeed in practice. The objections given are that skilled prospectors would not work for less than a half interest in a discovery, and that it is "extremely unlikely that there are any undiscovered visible outcrops of profitable ore on the public domain." Permit me to suggest that

no business scheme will succeed unless it is backed by confidence. It is likely that Mr. French, who believes in the idea, could organize a party of prospectors and stand a chance of unearthing something valuable. Mr. Platts probably would not 'make a go' of the plan, because he does not believe in it. It is so of any venture where the human element is important. Some men are always doing things that others said cannot be done. As to the statement that no "undiscovered outcrops of profitable ore" remain on the public domain, this may be true if the "outcrops" are such as any novice could spot as being valuable without effort. Mr. Platts can scarcely mean that no new mines will be discovered by prospectors. A chance blast here, a test-pit there, the extension of an old tunnel, the recognition of a commercially-new mineral, the skilled examination of an abandoned prospect-hole, all contain possibilities, especially in these progressive times. In the oldest of settled countries new mineral finds are constantly being made. Outcrops that men have looked at unseeingly for years are sometimes found to contain valuable mineral just under a surface stain or beneath a cover of moss. The rewards may not be so apparent as a generation ago, but prospecting isn't quite dead yet.

Berkeley, August 21.

P. B. McDONALD.

Another Apex Decision

The Editor:

Sir—Referring to your editorial on this subject in your issue of July 22, I note another of those gloriously impossible decisions that the judges are forced to give in an effort to get equity and justice out of the insane apex law.

I humbly beg to disagree with his honor, the judge, and through the medium of your valuable journal to offer a solution that should reverse the former decision on all true and logical grounds, as follows:

(1) That whereas title is dependent on the apexing within the claims, and whereas the present vein or veins do not apex on the present surface, a former geologic surface being assumed and admitted, therefore in all logic we must assume the geologic surface that existed when the veins did truly appear on the surface.

(2) That whereas by your evidence the veins are not a single saddle or anteline, but are two distinct veins, the one being probably more recent and having cut the other, and that they have therefore at some time both apexed at a geologic surface of greater elevation than the present; then it is clear that on the upward dip the vein DB apexed in the Jim Butler ground, and the vein CB apexed in the MacNamara ground, and the West End had no vein and no apex at all.

(3) Now therefore be it decided in all justice and equity that the vein within the MacNamara ground and downward to the centre of the earth belongs to the Jim Butler, and conversely the vein in the Jim Butler belongs to the MacNamara; and the West End having no right and title and no mine, shall pay to me a sum equal

to the value of ore already extracted as due and just compensation for my expert advice in the matter.

JOHN M. NICOL.

San Francisco, August 7.

The Mexican Tangle

The Editor:

Sir—Touching on Mexico again, a subject that seems to occupy all minds, I desire to discuss briefly an aspect of the problem that seems to occur to few, and certainly not to the many peace-at-any-price people I am amazed to meet here on this Coast, where they harp so much on that chimerical phantom, the Japanese peril. They say: "Why should the United States mix up in Mexican affairs, etc.?" No one wants the United States to intervene, much less, go to war with Mexico; and we who have all to lose and nothing to gain by such a course, desire it least of all.

By "We," I mean all foreigners who reside in Mexico and are carrying on the many industries that represent over two-thirds of the capital invested in that country. We have nothing against Mexico nor its people. We do not wish nor ask for intervention or war, although many of us fear that due to the omissions of the past five years, only the firmest, most honest, and most diplomatic endeavor can evade the former. We cede the right to the Mexicans to murder and rob each other to the point of extermination, if they so see fit; and we readily grant the contention that the American government should in no way mix up in Mexican politics, and certainly its citizens should not. But has Mexico no obligations to foreigners? Has the foreigner no rights under existing treaties?

Mexicans may have the right to ruin their own country, to murder and rob each other and to destroy the property of their own nationals; but when, in working their own sweet will in Mexico, they murder the foreigner and rob him, and by their acts ruin his property, destroying, and jeopardizing foreign interests that have been induced to go to that country under treaty guarantees, has the foreigner no right to expect protection from his government? Has his government no obligation to give him that protection? Has his government no right to demand that protection? These are the questions.

E. A. H. TAYS.

Berkeley, August 9.

The American Boy and the Mine

The Editor:

Sir—Mr. Burch's article in your issue of May 13 senses a fact which is becoming very evident throughout the mining regions. The good Cornishmen and the sturdy Irishmen are not sufficient in number to go around, in the increasing operations of this country, and many other nationalities are now employed.

The chief trouble with the workmen from central

Europe is their lack of experience in mining operations, their lack of knowledge of the language, the difficulty in making them comprehend and do efficient work. The fact that these workmen are liable to be fewer in number for several years to come, offers a chance for American young men in a business which is both attractive and remunerative.

Mining work has appealed to few of our young men, as it has necessarily meant hard manual work for which they, with their better education, usually consider themselves superior. The increasing efficiency of mining operations and the larger amount of work done by mechanical means now gives a better field for the intelligence of the educated American. There has been, and is now, better opportunity for young men in mining than ever before, and better than in many other occupations.

The mining companies employ a good class of workmen, but would find it to their advantage to follow the lines suggested by Mr. Burch and give them instruction, in order to make them more efficient. This is already being done to some degree in the weekly and monthly conferences that the larger mining companies arrange with their foremen and shift-bosses for the safety and efficiency of the men. Still better results would ensue if this scheme were enlarged so as to give general instructions to the men employed in the mine, and both officials and workmen would find it to their mutual advantage to have such courses arranged. Undoubtedly assistance could be given by members of the staff of scientific institutions, if available, in the vicinity, to assist and broaden the work.

A noticeable example in this line is that of the Cleveland-Cliffs company of Ishpeming, where a technical man of experience is giving instruction to the employees. This is helping the workmen in a very laudable and very decided manner and bettering both their operations and the community. Many mines, as well as other industries, have tried to get along with as few foremen and officials as possible. This error has been realized and is being overcome by the appointment of efficiency-engineers whose work, at times, necessarily conflicts or runs on the same lines with that of the foreman. It would be better if foremen and shift-bosses were increased in number and efficiency themselves, and gave more time to individual men. The Newport mine, in Michigan, one of the best managed large producers in the iron region, divides the mine into districts with 30 to 50 men each. The boss of each district and each of the men receive, besides their wages, an additional amount per ton hoisted, each day's work and the amount gained being made known the next morning. This gives a zest and emulation among all hands and the operations always have the close supervision and help of the district-boss.

The training that Mexicans have received from Americans in mining operations, in mechanical and metallurgical work, has enabled many of them to occupy positions of importance in that country and to do work for which it had been necessary to employ foreigners in the earlier operations that outside companies had undertaken. It

is worthy of note that, generally, throughout the Republic, the population of mining towns has not taken part in this fratricidal revolution, but has always been anxious to work.

Inasmuch as this country is anxious to have good workmen for its industries and accepts all classes from outside countries, it is certainly to the advantage of operators to train men in efficiency and in citizenship. If it be known to American young men that such training gives them opportunity to learn a business that is interesting, healthy, and remunerative, particularly with the more efficient methods now applied, more applications for employment will be received from them.

Mining operations nowadays depend, not only on a strong arm, but quite as much on some knowledge of ore, on the intelligent handling and care of drills and other mechanical appliances, and on adaptation in breaking and handling various kinds of ground. American young men have an advantage over their fellow-citizens fresh from other lands, and practical knowledge of mining operations gives them opportunity to be placed in charge of men, if they display energy and intelligence. It is too true that American miners have, in recent years, been in disfavor in the mines of California and other States, but there are examples of good material left to their own wandering devices, without just this interest in their welfare and training that Mr. Burch suggests.

ROBERT M. RAYMOND.

San Francisco, August 11.

Stamp v. Ball-Mill

The Editor:

Sir—The closing sentence of your charmingly unbiased criticism of stamps and ball-mills carries by implication a further criticism of milling practice on its psychologic side. You refer to the selection of machinery "in accordance with the spirit of the times; not stamps, but ball-mills." In other words, fashion affects the equipment of the milling-plant as well as dictating the cut of the coat and the shape of the hat that the manager wears.

Many will remember the days when the weight of the stamp began to grow. From a standard of 750 pounds it crept up to 850, to 1000, to 1250, and even higher. The manager of a small plant, where experimentation was out of the question, specified the heavy stamp, merely because it was in the spirit of the time. Then the higher weights lost favor, until the 950 to 1000-lb. stamp became standard. That meant simply that wide experience had shown this weight to give superior average results. It did not mean that it was best for every ore. No general rule can apply exactly. Many a mill is pounding away with 1000-lb. stamps upon ore that would yield better extraction if crushed with lighter, or perhaps with heavier, stamps. The difficulty is to find opportunity to test what conditions best suit any particular ore. Only large and wealthy corporations are accustomed to do this. The smaller and weaker concerns follow the fashion, assuming the prevailing practice to represent the

wisdom expressed in the law of averages. The same thing applies to the relative efficiency of stamps and ball-mills. The manager who follows the fashion is less open to criticism, even though he may obtain an economic result inferior to that which might be reached after careful experimentation. Capitalists usually expect an engineer to assume an attitude of infallibility in deciding upon a line of treatment. The suggestion of experimentation is received as an indication of weakness. Only those who have made a business of mining appreciate the superior understanding of him who regards the rules of the text-book and of current practice as expressing merely general principles which must be modified to fit special cases. In the hurry to begin production it may be safer to follow the fashion, but many a plant would soon demonstrate a financial gain by including in the design a flexible unit where the problems presented by the particular ore under treatment could be worked out at leisure.

No one can deny the greater economy of power in crushing by ball-mills instead of by stamps. If the extraction maintains a high average also, the ball-mill becomes fully vindicated in that instance.

No two ores will crush precisely alike, although the tendency to give similar screening-curves is pronounced when the crushing conditions are the same. Departure from this general principle depends upon the greater tendency of certain minerals to generate colloids in wet grinding. If the ores are crushed dry, and contain less than about 2% moisture, the curves will be nearly identical. Variation in the curve is obtained chiefly by changing the conditions of crushing. Therefore a direct comparison between two appliances so widely different as stamps and ball-mills is of no great value, so far as interpretation of screening-curves is concerned. It is a question as to the treatment that is to follow, and as to which pulp will yield the higher extraction.

The stamp produces fine stuff; it also produces slime, but not by any means as large a proportion as the ball-mill. Engineers are not in agreement concerning the relative degree of comminution effected in a ball-mill by shock and by abrasion. A third principle is also active: particles gripped by neighboring balls or pebbles are crushed in the same manner as in rolls. The probability is strong that far more crushing is due to this than to shock.

In the case of the stamp, the major effect is that of fine comminution due to rupture of the particles induced by what may be called the reaction from the die. An ore-particle upon which the stamp drops is first compressed. A series of compressive waves is consequently transmitted through the mass. On reaching the die these waves are reflected upward, and meeting the on-coming initial compressive waves overcome the cohesion of the mass, and fine comminution results. This takes place close to the die. The upper portion of the particle is more coarsely fractured. A fuller account of experimental data on this point, which I obtained some years ago, is quoted by Robert Richards in his treatise on 'Ore Dressing' (Vol. III, p. 1330). The result, then, is to

produce fine, not slime, except in so far as colloidalization occurs.

In the ball-mill the comminution, so far as produced by shock and radial crushing (as in rolls, *vide* Richards, *loc. cit.*) will also be granular, though very fine, but, to the extent that abrasion occurs, the tendency to sliming, both by flouring and by colloidalization, is enormously in excess of any similar effect yielded in stamp-milling.

The practical point to establish, therefore, is whether there be any gain in extraction. If very fine grinding be essential for releasing the metal to the attack of solvents, the ball-mill wins. If moderately fine comminution be sufficient, then the balance must be struck between the higher power-consumption in stamping and the lower extraction from a pulp presenting the difficulties due to high colloidal content. The latter difficulties are evidently threefold: protection of metal in colloidal envelopes, interference with free filtration, and adsorption of bases from the ionized solution, affecting both the dissolved metal and the base in the original solvent. Dry-grinding of ore containing not above 2% moisture will, of course, reduce colloidalization to a minimum, but drying costs money, and can be reckoned economical only in the face of a demonstrated increase in extraction sufficient to pay a material profit on that operation.

Crushing devices that utilize the principle of abrasion sometimes present peculiar phenomena. An illustration will best indicate my meaning. While making tests of material for cement manufacture I had to deal with a limestone which had been formed as a beach deposit in Tertiary time. It was essentially a mass of consolidated shell-débris, with many shells still quite perfect and retaining the naere as lustrous as when it had been washed by the ancient tide. From time to time floods had evidently invaded the lagoon and had carried silt to the lime-beds, which, however, introduced no technical difficulty; but what appeared more serious was the fact that these thin layers of silt often contained quartz-sand in considerable quantity. Chemically the limestone, although rather high in alumina and silica, would make an ideal 'mix' with limy clays available in the neighborhood. The question was whether the flouring of this free silica would prove too expensive by prolonging the time of grinding, thus adding a prohibitive power-cost. After the first charge had been treated in the tube-mill, I was shocked to see the large amount of granular material remaining in my testing-sieve. A gleam of mother-of-pearl, however, gave a hint of the truth. The residue was soluble in cold hydrochloric acid. The quartz grains had been successfully floured, but the shell-naere, which seemed relatively so soft, had resisted abrasion the longer. Similar peculiarities are displayed by many gangue-minerals in ores which one would expect to be readily reduced to fine.

COURTENAY DE KALB.

Tucson, August 22.

GOLD received at the San Francisco Mint during July totaled 260,425 fine oz., and 191,383 oz. of silver. There was no coinage on account of the annual settlement. The vaults contain \$370,535,105.84.

Molecular Forces and Flotation

By Will H. Coghill

The warning about young men specializing in flotation, as sounded by E. P. Mathewson in a recent number of the PRESS, should be considered by all who are directing these men in their education. It provokes the question that ever confronts the instructor in a technical school.

The student may be drilled on the design and construction of the various flotation machines, and the methods and results of the experimenters, and be sent into the field feeling that he is strictly up-to-date, but his school-work would not amount to much if he has been taught only the ever-changing art. He would have acquired something more enduring and be better prepared to benefit from his college course had he been taught natural laws with enough of the art to give a view of the field to which the laws could be applied, for man's methods are ever changing while Nature's laws are invariable. The processes of a few years ago are now obsolete, but the principles upon which they were founded will be applied to new methods for generations to come.

To the workers in flotation has fallen the problem of outlining the rudiments, and then by means of laboratory experiment, made by aid of the results of workers in the related sciences, develop flotation to the point where scientific reasoning may be applied to direct tests on ores as is now done in cyanidation. It took twenty years to develop the science of the cyanide process. It will take as long in flotation if we continue our antiquated methods. So far as I can learn, not more than two of the great number of recent contributors of articles on flotation have had an opportunity for a deliberate study of the related sciences. The rest of us have a job to look after and are busy enough attending to it. Advancement is, therefore, slow. The papers by O. C. Ralston and E. E. Free are, of course, excellent. But in many cases they shoot above our heads; for this we and not they are to blame.

The majority of the workers in flotation who have had the advantage of a school of mines training have taken only the prescribed four years and then hurried into the business of mining. Their love for science was none too great when they left school and the constant employment in the art has in no way tended to increase it. By a careful reading of the articles mentioned they might hope to glean some fact, the knowledge of which would be of aid in the art of metallurgy, but the material is entirely too heavy for one who has not had a special training in science.

We should learn to think—not parrot the statements of others—in terms of the molecule before science will be of aid to us in flotation. We cannot adjust ourselves to this in a moment. It requires time and effort. Many of us have sat aglance while an astronomer spoke of distances

in terms of the diameter of the earth. We must now go to the other extreme and become familiar with molecular dimensions. This requires much study, but in it we acquaint ourselves with the observations of physicists and chemists so that we are not likely to spend valuable time in discovering something that is already known.

The mastery of science is not easy. While in school we had to learn the chapters page by page, but this does not seem to be the best way for those without an instructor. To advise one to go through a book rapidly, gathering only an idea here and there, and through it again, may seem to be superficial. But the aim is to master the subject and this is doubtless the way to do it. This method of study is endorsed by Dr. V. H. Gottschalk¹ when he says: "After several readings of the short paper on * * *, read first the excellent summaries at the end of * * * before undertaking a rapid survey of the whole set; follow this by a more careful consideration of the summaries with re-reading of portions of the text when necessary; continue this process until the drift of the argument begins to reveal itself."

One contributor has said that the scientific man has aided little in flotation. Indeed he is correct, and so is the old-timer who says that more mines have been discovered by simple prospectors than by mining engineers. The ratio of those who pursue the right methods to those who have no method at all is as 1:1000.

Have any of the big companies put their engineers on retainers so that they could review the fundamentals of science and pursue post-graduate work in a university where they could have access to a complete library? Probably none, because the American business man goes straight for the dollar and must see the wheels turning before he is assured of dividends.

Some of the blunders that have crept into the articles on flotation are a great drawback to those who wish to learn but find their library incomplete. One writer has said, for example, "the cohesion of water varies as the temperature * * * and at the boiling point there is no cohesion." This statement is misleading. Scientists had this problem pretty well in hand nearly a century ago and knew that surface tension became zero at the critical temperature and not at the boiling point, as we ordinarily use this term. Brunner² recognized this fact in 1847 and knew that sur. ten. decreases with rising temperature until the critical point is reached, when liquid and vapor become identical and sur. ten. is zero.

In the Smithsonian Physical Tables, the sur. ten. of

¹Bibliography, 'Concentrating Ores by Flotation,' University of Missouri.

²'Physical Chemistry,' Ramsey and Smiles.

water at 100° C. is given as 61.5, and nothing is said about boiling point.

Since critical temperature is so closely related to sur. ten. it is obvious that we shall acquire a working knowledge of it. At one time it was considered sufficient for us to be able to say that critical temperature was the temperature above which a gas could not be liquefied no matter how great the pressure. This served the purpose for which it was intended, but it is inadequate for us now. If we define it as the temperature at which the sur. ten. between a liquid and its vapor becomes equal to zero, and any meniscus or bounding surface disappears, we have added to our knowledge of molecular forces.

It follows that when liquids are near their critical point, for example, condensed gases, they will have small sur. ten., while liquids far removed from their critical point, such as molten metals and fused salts, will have large surface tensions.

Liquid carbon dioxide is an example of a liquid that is near its critical point at atmospheric temperature; the critical temperature is 31°C. Its sur. ten. is therefore very small unless artificial refrigeration is used.

Mercury, on the other hand, at atmospheric temperature, is so far below its critical point that it would be expected to have a great sur. ten. as indeed it has.

To aid further in getting the relation of critical temperature to sur. ten., I quote from Ferguson.³ He indicates their relation and the basis on which sur. ten. of liquids should be compared, saying: "In earlier researches on the subject, comparisons [of sur. ten.] were made at the same temperature, but it was recognized by Schiff that sur. ten. should be compared at corresponding temperatures, that is, at temperatures which are equal fractions of critical temperatures of the liquids under consideration." Continuing, we find him stating the relation of critical temperature to boiling point, thus: "Unfortunately the critical temperature of comparatively few organic compounds have been directly determined, and it was supposed that these conditions were fulfilled at the boiling point of the liquids examined. If this be the case the ratio of the boiling point to the critical temperature of all liquids should be the same where temperatures are measured on absolute scale."

The degree of exactness with which this condition is fulfilled is remarkable, as can be seen by an examination of tables published by Ferguson, also those in the 'Handbook of Chemistry and Physics,' and elsewhere. They show the value of this ratio calculated from a number of substances of very diverse boiling points.

An examination of these tables shows that it is a fairly accurate generalization to put

$$\text{Boiling point} = 0.656 \times \text{crit. temp.}$$

where temperatures are measured on the absolute scale; so that from the boiling point we can calculate the critical temperature (subject to an error of not more than 5% in the case of the carbon compounds). For a proof that vapors as well as liquids are regarded as having molec-

ular cohesion, one has only to refer to Van der Waals' modification of Boyle's law.

The toy-balloon theory⁴ that each molecule of water is drawn toward the centre of gravity of its mass cannot be taken as a substitute for the accepted theory of sur. ten., for it is not in accord with physicists either here or abroad. They generally agree that the radius of molecular attraction is insensible but finite. They are of one accord in the opinion that "every molecule⁵ attracts every other molecule that may happen to be within a certain distance from it, which we denote as the sphere of molecular attraction. In the body of the liquid, this attractive force is more or less neutralized by the fact that the molecule we are considering is surrounded on all sides by others, all pulling in different directions. Hence the combined effect is practically zero. At the surface, however, all the molecules are below it, and there are none above to neutralize the force they exert. There is thus a strong downward force tending to drag the molecule into the surface. This force makes itself manifest in the phenomenon known as 'surface tension' or 'capillarity.'

Methods of ore-dressing today fall under one of two heads, gravitation or flotation. The fundamental law of the former was discovered by Archimedes, that of the latter by Leslie. Archimedes, as we know, while in his bath, noticed the loss of weight of his own body and it occurred to him that any body immersed in a liquid must lose a weight equal to the weight of the liquid displaced. Leslie, a British scientist, was the first (1802) to give a correct explanation of the rise of a liquid in a tube.⁶ Archimedes considered only the force of gravity on known masses; Leslie took into account the molecular force. It is Archimedes v. Leslie. Metallurgists have written much on Archimedes' law and very little on Leslie's, the latter having been left to the physicist and chemist.

It is surprising how little attention metallurgists have given to the application of the physical principle discovered by Leslie. Until recently they have been quite satisfied to call it 'capillarity' and let it pass. Capillarity has made itself manifest to us in many ways. Richards speaks of it in his 'Textbook of Ore Dressing' under the subject of amalgamation. He says that the capillarity of mercury is negative except with those metals with which it easily amalgamates; and the trouble due to grease is familiar to mill-men. In cupellation, the lead oxide is drawn into the pores of the cupel, while the lead ignores them and tends to shape itself into a sphere. Were it not for molecular cohesion the resulting silver bead would flatten and become so contaminated by the cupel that its subsequent treatment would be difficult. Galena⁷ penetrates the fire-brick of the furnaces in which it is treated. Often a network of small veins of bright crystalline galena is found in furnace linings. The

³Dudley H. Norris, in M. & S. P., Feb. 12, 1916.

⁴'Molecular Physics,' Crowther.

⁵Some authorities state that Laplace first developed, about 1807, a theory of capillary action.

⁶'Metallurgy of Lead,' Hoffman. P. 8.

molecular deportment of galena and litharge is quite different from that of lead itself.

In zinc smelting it is necessary to re-work the 'blue powder' because the film of oxide,⁸ which coats each particle of zinc, prevents coalescence. The forces that control the films on blister-steel and blister-copper are identical with those that maintain the form of the soap-bubble.

The geologist has studied the bubbles in lava and has found that the vesicles⁹ are roughly spherical. This spherical shape cannot be maintained unless the pressure on the inside is greater than that without. Only surten, can account for this excess. He is also aware that if the wick of a lamp touches water,¹⁰ the latter rises through the capillaries previously filled with oil, makes the flame sputter, and often extinguishes the light. In the same way water will pass from the coarse spaces of sand or from fissures into the fine capillaries of shale, displacing the oil, which is thereby forced into the sand through neighboring pores. The cohesion that holds

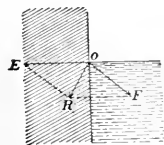


FIG. 1.

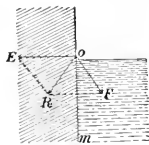


FIG. 2.

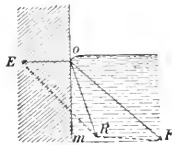


FIG. 3.

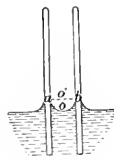


FIG. 4.

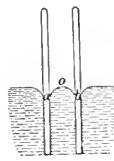


FIG. 5.



FIG. 6.

together the particles of a crayon and adhesion of the chalk to the blackboard, or of dust to a mirror, are all evidence of molecular force. Many of the examples cited come under 'capillarity,' but since that is difficult to define and is therefore likely to be used to cloak ignorance, I shall not attempt a definition. Molecular cohesion and adhesion, and probably molecular repulsion, must be studied in detail.

A study of capillarity is of great aid in gaining a conception of the conduct of the molecular forces of cohesion and adhesion that cause some substances to float on the surface of a liquid while others sink. I quote from a high-school book on physics,¹¹ which to my mind, gives one of the first lessons in the science of flotation. The discussion is as follows: "We must keep in mind two familiar facts: first, that the surface of a body of water at rest, for example a pond, is at right angles to the resultant force, that is, gravity, which acts upon it; second, that the force of gravity acting on a minute amount of liquid is negligible in comparison with its own cohesive force. Consider then a very small body of liquid close to the point *O* (Fig. 1) where water is in contact with the wall of the glass tube. Let the quantity of liquid con-

sidered be so minute that the force of gravity acting upon it may be disregarded. The force of adhesion of the wall will pull the liquid particles at *O* in the direction of *OE*. The force of cohesion of the liquid will pull these same particles in the direction of *OF*. The resultant of these two pulls on the liquid at *O* will then be represented by *OR* (Fig. 1). If then the adhesive force *OE* exceeds the cohesive force *OF*, the direction of *OR* of the resultant force will lie to the left of the vertical *OM* (Fig. 2) in which case, since the surface of the liquid always assumes a position at right angles to the resultant force, it must rise up against the wall as water does against glass. If the cohesive force *OF* (Fig. 3) is strong in comparison with the adhesive force *OE*, the resultant *OR* will fall to the right of the vertical, in which case the liquid must be depressed about *O*. Whether then, a liquid will rise against a solid wall or be depressed by it will depend only on the relative strengths of the adhesion of the wall for the liquid and the cohesion of the liquid for itself. Since mercury does not wet glass¹² we

know that cohesion is here relatively strong, and we should expect, therefore, that the mercury would be depressed, as indeed we find it to be. The fact that water will wet glass indicates that if this case adhesion is relatively strong, and hence we should expect water to rise against the walls of the containing vessel, as in fact it does. As soon as the curvatures just mentioned are produced, the concave surface *aob* (Fig. 4) tends, by virtue of surface tension, to straighten out into a flat surface *ao'b*. But it no sooner begins to straighten out than adhesion again elevates it at the edges. It will be seen, therefore, that the liquid must continue to rise in the tube until the weight of the volume lifted balances the tendency of the surface to flatten out. Similarly a convex surface *aob* (Fig. 5) falls until the upward pressure at *o* balances the tendency of the surface *aob* to flatten out."

If, in the case of water against glass, the water is pulled upward and in the case of mercury against glass the mercury is pulled downward, the converse must also be true, namely, that in the former the glass is pulled down and in the latter the glass is pushed up.

Now assume that you had two minerals so that they are partly submerged by a liquid and that with one adhesion is very great (relatively) and that with the other the adhesion is very slight. It is obvious that the

⁸'Metallurgy of Zinc and Cadmium,' Ingalls, p. 526.

⁹'Igneous Rock and Their Origin,' Daly.

¹⁰'Rôle and Fate of Connate Water in Oil and Gas Sands,' R. H. Johnson, Bull. No. 98, A. I. M. E., p. 221; also 'Capillary Concentration of Gas and Oil,' C. W. Washburn, Bull. No. 93, A. I. M. E.

¹¹'A First Course in Physics,' Millikan and Gale.

¹²It is a well known fact that there is a slight adhesive force between mercury and glass and that mercury exerts an attractive force upon air, but the quotation suffices for the present.

surface of the liquid will turn up at the contact with the former and down and around the other, and that if these particles are so small that the force of gravity is negligible it is impossible for the former to float and just as impossible for the latter to sink. One of them cannot ride on the surface and is actually drawn into the liquid like gold into mercury, while the other cannot by any means enter the liquid unless its mass is sufficient to overcome the contractile force in the surface of the depressed liquid.

This process of reasoning is what I consider to be a natural and correct result of the study of the cause of capillary rise and depression as presented by Millikan and Gale, and to show that my conclusions are in harmony with their ideas I quote them again, where they discuss the floating of a needle. They say: "So long as the needle is so small that its own weight is no greater than the upward force exerted upon it by the tendency of the depressed liquid surface to straighten out into a flat surface, the needle could not sink in the liquid, no matter how great its density. If the water had wet the needle, that is, if it had risen about the needle instead of being depressed, the tendency of the liquid surface to flatten out would have pulled it down into the liquid instead of forcing it upward. Any body about which the liquid is depressed will therefore float on the surface of the liquid if its mass is not too great."

If the needle floats, the surface is turned downward, as in Fig. 3, where the resultant of the parallelogram of adhesive and cohesive forces lies in the liquid; and if it sinks, the surface is turned up, as in Fig. 2, where the resultant lies in the solid. Therefore, may we not say that if we can draw the resultant of the forces of cohesion and adhesion when a mineral is in contact with water, we can predict whether or not it is floatable; for if the resultant lies in the liquid (Fig. 3) it will float, and if it lies in the mineral (Fig. 2) it will sink.

We note next that when water is in contact with quartz the resultant lies in the solid; when it is in contact with galena¹³ the resultant lies in the liquid. We can, therefore, separate galena from quartz by flotation. I believe it to be quite possible for us to use a contaminating substance in the water and thus vary the molecular attractive forces so that with some sulphides the resultant lies in the liquid and with other sulphides it lies in the solid. This, indeed, has been done, and I believe that this idea is essential to the understanding of selective and differential flotation. To be sure, the introduction of the parallelogram of forces is only a shift from one series of unknowns to another, but it affords a means of stating the problem accurately, which is the first step in a solution.

The reader here exclaims: "Oh well, you are talking about film-flotation?" I think that anyone who will give serious thought to the above demonstration of capillary rise and depression will be convinced that there is

nothing but film-flotation.¹⁴ All flotation depends upon the film. If a piece of sulphide is brought to the surface by a bubble, it is, indeed, riding on the wall of a hole in the water, the only difference between this and what is commonly meant by film-flotation being that the hole is a sphere with finite radius while in 'film-flotation' the surface of the wall has an infinite radius.

If this is true, we go too far afield when we marshal osmosis, new-born gas, static charges, etc., for a first lesson in flotation.

Many writers have expressed a desire to discover the nature of the forces that cause a sulphide particle to cling to a bubble. I think their desire will never be appeased, for there is no such adherence, except insofar as there is a slight adhesion of the liquid film to the mineral as it rides in the cavity in contact with the wall or on a plane surface. With this exception, a bubble does not cling to a sulphide particle in a flotation-cell any more than butter clings to our fingers when we carry a pound of it from the store.

What has been observed, and not properly interpreted, is the coalescence of two cavities, one of which is filled with mineral and the other with air, where the mineral is brought to rest on the wall of the resulting cavity or, perchance, the walls of the two cavities do not break through but merely cling together.

A piece of submerged galena is just as surely surrounded by a sur. ten. liquid film as is the air-bubble or submerged greased needle. If this is not plain look again at the familiar cross-section of the floating needle, Fig. 6. That the film extends below the needle there is no question, and it is just as sure that if the needle were submerged the film would surround it. It is obvious that any submerged solid is surrounded with a liquid film when the resultant lies in the liquid, for this resultant represents an inward drawing of the molecules that causes the contractile force known as surface tension.

If a piece of quartz impinges against the wall of one of these cavities and has not sufficient kinetic energy to carry it through, as a bullet pierces a thin board, the rise of the liquid about it and the contractile drawing of sur. ten. will cause it to retreat directly into the liquid just as surely as the glass tube in Fig. 4 is pulled into the water. If it has sufficient energy, so that it can pierce the wall where it first impinges and falls on the wall in another place, it will likewise be cast out of the cavity. When a piece of galena hits the wall the conditions are entirely different; for the galena fills a cavity that has walls just like those of the bubble and what happens is nothing more or less than the coalescence of two bubbles. If the impact is very slight they might only cohere, and thus give the appearance of a mineral grain clinging to the bubble, when in fact it is the bag about the mineral that has become attached.

It is commonly accepted that a hole in water filled with air is encased in a sur. ten. film; by applying the prin-

¹³Galena and quartz are here supposed to be in such condition that they are typical of floatable and non-floatable minerals.

¹⁴This statement applies to the processes now in operation, not the original bulk-oil method of Elmore.

ciples set forth by Millikan and Gale one sees that a similar encasing film exists when the hole is filled with either a greased needle or galena. In the first case there is a wall of air; in the second, a wall of grease; and in the third, a wall of galena.¹⁵ In every case the resultant of cohesion and adhesion is such that it lies in the liquid. A piece of glass submerged in mercury would be surrounded by an extremely strong film. If glass is submerged in water there is no sur. ten. liquid film.

I have cited an instance where there is no liquid encasing film at all (glass-water interface) and one where the film is excessively strong (glass-mercury interface). May not these extremes be plotted and connected by a continuous curve with points to show the tension at the solid-liquid interface of various combinations of substances? Yes, and more than that. One end of the curve might represent great sur. ten. in the surface of the solid and the other end a great sur. ten. in the sur-

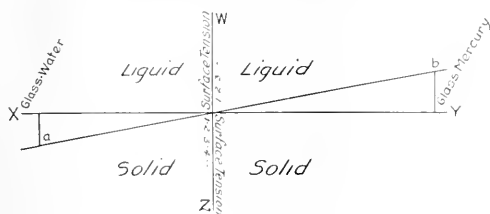


Fig. 6a.

face of the liquid. Fig. 6a is a diagrammatic sketch to show this. The sur. ten. of the glass-water interface, where the resultant—and therefore the sur. ten.—is in the solid, is placed at one end and the curve passes through a zero sur. ten. to an extreme point representing tension at the glass-mercury interface.

If the resultant lies in the solid there is no liquid film, but, instead, a sur. ten. solid film, and the sur. ten. would plot on *ao* in the quadrant *xoz*; while if the resultant is in the liquid there is a liquid film and the sur. ten. would be indicated by a point on *ob* in the quadrant *woy*. It seems to me obvious that the non-floatative minerals would plot to the left and the floatative minerals to the right of *zw*, and that such minerals as fluorite, garnet, and calcite, which have been described as at times inclined to float, would be placed very near *zw*.

Since I have said so much about the encasing sur. ten. film, it might be well to see if the workers in colloid chemistry take cognizance of this sort of thing. Indeed, we find that there is no lack of precedents. The idea of films around small particles has long since been accepted, and furthermore, before the Wilfley table was invented, they knew that it was the coalescence of these films that caused aggregation. I quote from 'Colloid Chemistry' by Ostwald, page 88: "Stress was laid upon the importance of these envelopes in phenomena of condensation early in the history of colloid chemistry. This, J. M. van Bemmelen wrote in 1888: 'I think it possible that

the formation of the flakes which are precipitated in a liquid is dependent upon a change in the surface tension of the liquid membranes surrounding the colloid particles, of such type that these membranes between the particles are torn at some point, thus permitting the particles to form aggregates.'"

This excellent picture of aggregation tempts me to quote more of Ostwald's text, but we must leave it and finish the high-school book before taking up a more advanced work. In doing this let us make some simple tests. Touch the round end of a glass rod to the surface of water. No sooner does the smallest physical point come in contact with the water than the water seems to jump to the rod and spread over the end as if it were magnetized. We say, that is to be expected, that is capillary rise. Observing that there must be a great pressure exerted upon the film that is pulled to the glass rod with such manifest energy, we explain the spreading and consequent rise in the terms of John Leslie, who, in 1802, said: "The result of this pressure if unopposed is to cause this stratum to spread itself over the surface of the solid as a drop of water is observed to do when placed on a clean horizontal glass plate; and this even when gravity opposes the action, as when the drop is placed on the under surface of the plate."

Since this plain and simple reasoning of Leslie's is credited by Clerk-Maxwell as being a correct explanation of the rise of a liquid in a tube and further, since it leads us to the same conclusions as does the 'component and resultant' method of Millikan and Gale, we feel an added security and proceed with a similar test using a different solid substance. Let us take for this test a fragment of galena and touch it gently to the surface of the water. Does a dimple appear immediately to indicate the presence of a membrane that is resisting rupture? Not so. The water jumps to the galena much as it did to the quartz, though probably not so vigorously. We argue that this is not in accordance with our expectations; thereupon we repeat the test and make sketches.

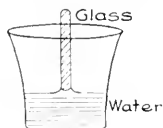


Fig. 7.



Fig. 8.

Fig. 7 shows how the surface of the water is elevated to wet the glass rod, and Fig. 8 shows much the same sort of phenomenon when galena is used. Though badly confused, we decide to carry the test one step farther. To do this, press the end of the glass rod below the natural surface of the liquid and also allow the galena to float. Fig. 9 and 10 show a cross-section through the contact of liquid and the two solids.

The liquid is now plainly elevated around the rod and depressed around the galena. This seems perfectly natural and satisfactory; but how about the rise of the liquid in Fig. 8 where galena seemed to be wetted? It

¹⁵Whether or not galena be surrounded by a film of adsorbed air or grease does not concern us now.

is nothing more nor less than adhesion, a component that must be reckoned with, however small it may be, as, for example, in Fig. 3, where mercury is in contact with glass. Let us prove that there is adhesion between mercury and glass. To do this we will take some mercury in a watch-glass and use the same glass rod. If we watch

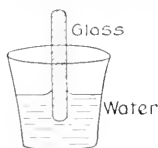


Fig. 9.

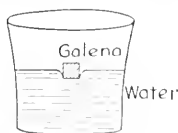


Fig. 10.

closely, as we lower the rod to meet the mercury, we can see that the mercury rises a little around the end of the rod at the instant they come in contact. See Fig. 11. Upon pulling the rod away it is plainly seen that there is adherence. Having performed this experiment we may go into the mineralogy laboratory with a beaker of water and find that any one of a dozen minerals taken at random adheres more or less firmly to water. In some cases, when the mineral is pressed below the surface we can detect capillary rise and in others a depression.

Then what does our popular term 'wetting' mean? It can mean nothing more than absence of repulsion unless we give it a special definition, as some physicists have done. As for the spreading, Leslie, the sage of more than a century ago, in speaking of adhesion of a liquid to a

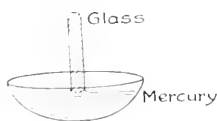


Fig. 11.

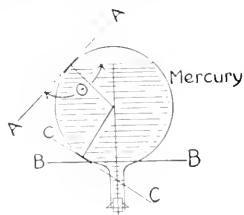


Fig. 13.

solid as indicated in Fig. 7, 8, and 11, said: "the result of this pressure, if unopposed, will cause the liquid to spread." When the adhesive force is sufficiently in excess of the cohesive force the liquid will spread indefinitely, regardless of gravity, until the thickness is such that it could only be measured in terms of the diameter of a molecule. If the solid body attracts the liquid strongly enough it will draw every particle of it as near as possible to itself. Thus it is that a liquid spreads over certain clean surfaces. But such perfectly clean surfaces¹⁶ are difficult to obtain and that on account of this very phenomenon. Thus, the least drop of oil touching a glass surface spreads over it quickly and completely changes the effect of adding a drop of water. Such department needs no emphasis to impress those interested in the laws relating to flotation.

The spreading of a group of molecules of water within

the radius of molecular activity of the glass is analogous to the spreading of a ball of soft putty while resting on a plane surface. In both cases the distortion is due to attraction; in the first, the attraction is called molecular; in the second, gravitational.

But analogies do not satisfy us; we are seeking the foundation of a new and important science, and there will be opportunities for analogies later. Leslie said "if unopposed." We shall do well to deal with components and not generalities. We are reminded therefore how we stated above that in some cases, when the mineral was pressed below the natural surface of the water, we could detect capillary rise and with other minerals a depression. This statement must be considered with caution lest we let important facts slip our attention.

Look again at Fig. 4 and 5. Shall we agree that in contact with a perfectly clean piece of glass the surface of water always turns up and that of mercury always turns down? You say, Yes; that has been proved. Not so; and here, as has often been our experience we find that we have to unlearn what we have once learned. Let us place a glass rod in mercury so that it will rest in a position, not vertical as in Fig. 5, but in an inclined

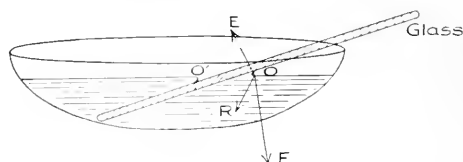


Fig. 12.

position, and draw the components of adhesion and cohesion and their resultant. See Fig. 12.

Now we know that the surface of a liquid tends to adjust itself at right angles to the resultant of the forces acting upon it and that if gravity predominates the surface is horizontal. But let us consider a group of molecules at O so small that the molecular forces predominate over gravitational forces. We have the force of adhesion OE acting at right angles to the surface of the glass and pulling the molecules to it and the cohesion of the liquid pulling these same particles in the direction of OF . The resultant of these two forces, OR , is the force to which the surface assumes a position at right angles, and since OR lies to the left of a vertical line through O it is apparent that the surface of the mercury must turn up to meet the glass. In like manner it can be shown that the mercury turns down to meet the glass at O' . Since the mercury turns down at O in Fig. 3 and up at the same contact in Fig. 12, it is obvious that there is a slope of the glass at which the mercury would stand level. It may seem bold to draw these components so freely when so little is known of their absolute value. It must be said in explanation that they are only diagrammatic and that is all that Milligan and Gale intended. It is a fact, however, subject to a simple ocular demonstration, that mercury does turn up to meet the glass at O and down at O' Fig. 12. The point to be

¹⁶Mechanics, Molecular Physics, and Heat. Millikan.

made is that in both cases the resultant lies in the mercury, even though the mercury turns up to meet the glass as does water against glass where the resultant lies in the solid, and that the slope of the liquid contact must be considered only in connection with the angle at which the mineral meets the original surface of the liquid. The elevation of the mercury at *O* does not mean that the sum-total of all the forces tends to pull the glass down as does water pull the glass in Fig. 4, for we must remember that the film of mercury extends entirely around and under the glass and that it tends to contract and reduce its distorted sur. ten. film to a minimum. It will therefore push the glass upward if the downward component due to weight of the glass is less than the upward component due to the contractile force of the liquid.¹⁷ Briefly stated, an upturned liquid does not always indicate that the resultant turns into the solid as one would conclude from a study of Fig. 2. By the purely theoretical treatment of components adopted in Fig. 12, one can show that the surface of water also may well be approximately horizontal when in contact with glass.

After reaching these conclusions by merely "reading between the lines" of a most elementary physics and checking them by laboratory tests, it is interesting to note that a more advanced text-book¹⁸ gives further corroboration in the recitation of a "test to determine the angle of contact of mercury with glass."

An inverted spherical flask, as shown in Fig. 13 is used. The quantity of mercury in the flask is adjusted until its surface in contact with the glass is horizontal.

Then $\frac{d}{2} = r \cos (\Theta - \frac{\pi}{2})$, where Θ is the angle of contact sought, d = diameter of circle of contact of mercury and glass, and r = radius of the spherical flask.

Likewise the surface of water would be about as shown by line *BB*. Contamination of the glass or liquid might well give surfaces that lie anywhere between the two mentioned. This might be called a reciprocal method for determining the angle of contact; for in this test the liquid surface is horizontal and the solid surface is inclined, while the angle of contact, as we are accustomed to thinking of it, appears with an inclined liquid surface against a vertical solid surface. The 'direct' position of



Fig. 11.



Fig. 13 appears in Fig. 14 where *AA* and *CC* are vertical. This shows the same angle of contact in a position more familiar to us.

The foregoing shows that it is insufficient to say that the liquid turns up or down. The angle of contact must be given; it is the same regardless of the slope of the

solid surface. For example, in Fig. 12 the angle of contact at *O* must be the same as at *O'* and again the same at *O* in Fig. 3. Again the actual angle of contact may be distorted by the weight of the mass as, when a drop of mercury rests on glass.

The question may well be repeated: Is it correct to speak of a sur. ten. film of mercury against glass, and if the term is correct, do we need added evidence that it does exist at the mercury-glass interface?

In our first conception of the film we thought only of the upper horizontal surface of a liquid, that is, the liquid-air interface of standing water. We then extended it to include the walls of a submerged air-bubble, and now the only rational application of film or membrane is to include also all interfaces where there is sur. ten. If there is a solid-liquid interface in which the resultant turns into the liquid, the membrane is in the liquid, and if the resultant turns into the solid, the membrane is in the solid. It is of the utmost importance that we add contaminating substances to the mill-water that will cause the membrane surrounding the grains of ore (sulphides) to be in the liquid and simultaneously cause the membrane around the gangue to be in the solid. Since the solid membrane is an intangible sort of a thing because it is solid, it is best to deal with its antithesis: the absence of a liquid membrane. It may well be said therefore that when the flotation metallurgist has contaminated his liquid so that there is a liquid membrane around the ore particles and none around the gangue, he has mastered the first step in his process.

The liquid film must not only surround the ore particles, but it must be of such a nature that it will rupture at the point of contact with an impinging air-bubble and thus cause coalescence; or if coalescence does not take place the films must cohere. This is the second step.

Reference to another simple and familiar physical experiment may be of service here to give added evidence that when mercury is in contact with glass the membrane is in the liquid—a state quite different from water in contact with glass—and aid in further acquainting us with laws second to none in their application to flotation, the laws of molecular cohesion and adhesion.

Take two conical capillary tubes, *a* and *b*, Fig. 15.



Fig. 15.

Place mercury in *a* and water in *b*. The mercury will at once run to the large end and the water as quickly to the small end of the respective tubes. The mercury will travel to the larger end of the tube even though it be slightly elevated. In doing so, it decreases its surface and finally reaches the point where the diameter of the tube is sufficient to allow it to assume the form of a sphere. Such conduct is possible only when a liquid is surrounded by a sur. ten. liquid membrane. Here, with the mercury, surface energy in the liquid, after its well-known manner, tends to reduce the amount of surface to

¹⁷Here the principle of Archimedes, namely, loss of weight due to displaced liquid, is not taken into account.

¹⁸'General Physics,' by Edser, p. 306.

a minimum. The same components exist in *b*, but they are of different magnitudes and are such that the liquid membrane is only at the liquid-air surface, and it is obvious that it is reduced by a movement toward the small end. The concave water membrane at the ends are similar to the piston of an hydraulic press, and the liquid is drawn in the direction of the greatest force per unit of area. If we assume that these concave surfaces are hemispherical it is obvious from the formula, $P = \frac{2T}{r}$ that the drawing forces per unit of area toward the ends are inversely as the radii. If the liquid film extended entirely around the water such an increase in total surface could not happen.

"At a solid liquid interface two cases are therefore possible—sur. ten. in the same sense as in the case of the gaseous bounding medium may appear or," according to Wilhelm Ostwald, "we may have a surface tension of the opposite character. In this the (liquid) surface does not tend to become as small as possible, and we say that the solid body is wet by the liquid. Mercury on glass is an example of the first; oil on glass, of the second. When the surface of a solid is wet by a liquid, it (the solid) acts like the surface of a liquid, and therefore seeks to become as small as possible."

At this point an analogy may be of value, not as a proof but as an aid in showing how the deportment of mineral grains in a flotation-cell might well depend on whether they are or are not surrounded by a liquid film.

In this hypothetical case, we grant first that it is a physical fact that glass submerged in mercury is encased in a liquid membrane; that this membrane is squeezing the glass in accordance with the formula $P = \frac{2T}{r}$, in the same manner as if air occupied the hole in the mercury in place of the glass. Second, let us remind ourselves of the great 'affinity' of mercury for gold. This affinity or capillarity¹⁹ is well known and one only needs to be reminded that gold is drawn into mercury²⁰ in the same manner as glass is drawn into water to see that they are perfectly co-ordinate.

We take a pulp composed of mercury, particles of gold, and crushed glass; we place it in a Callow cell and blow air through it. Can you conceive of the gold entering or even clinging to an air-bubble? No, you would not think of such a thing any more than you would of the gold in the amalgam on the copper plates mysteriously popping to the surface and parting company from the mercury. But, on the other hand, consider the glass. It is surrounded by a liquid membrane of mercury. If this membrane comes into contact with the membrane of an air-bubble and bursts at the junction, the glass will be squeezed out of its little sack into the large one and ride securely to the surface on the wall of

the resulting bubble. Thus the cell would produce an overflow of glass and an underflow of mercury with the gold. If we replace mercury with water, glass with galena, and gold with quartz, and adjust the detail by means of a contaminating substance, we afford a complete and perfect transfer from an hypothetical to an actual operating flotation-cell. Unfortunately, too many of us have concerned ourselves so much with detail—the contaminating substances, etc.—that we have failed to grasp the fundamental idea. Electrolytes, static charges, osmotic pressure, and much of the researches of recent workers in physical and colloid chemistry will all have their places in the science of flotation after the foundation has once been laid.

Archimedes was interested only in the mass per unit of volume, Leslie in the manner in which the molecular forces of a substance affected an unlike substance. Since the range of action of molecular forces is so very small it is obvious that only those molecules at the surface could be sufficiently close to another substance to affect it. We are interested, therefore, in the forces at the common surface of two substances. In this, our position is the same as that of the chemist. Bigelow²¹ says, "more and more we are realizing that the conditions in contact surfaces often play the decisive rôle in important processes."

I have tried to expose the fallacy that mineral particles adhere to impinging bubbles; as an alternative, I have advanced a theory involving coalescence, this being more in accord with scientific ideas.²² We are familiar with the coalescence of two soap-bubbles, but have much to learn concerning the coalescence of two films when one of them surrounds a solid. Here I would recommend a study of boiling in the volume on 'Heat' in the 'Text-Book of Physics' by Poynting and Thompson. It teaches that the bubbles which carry the steam to the surface of a liquid do not rise from points at random, but from definite points or particles of foreign matter that form a boundary of the liquid. There must be a nucleus in the shape of a minute bubble into which the steam passes. As evaporation proceeds, the bubble grows and finally breaks away, always leaving a small portion behind as a nucleus, just as part of the neck of a drop of water is left when the drop breaks off from a surface. Some substances carry a great many nuclei while others are barren. A beaker, thoroughly cleansed in hydrofluoric acid, is so barren of nuclei that water can be raised several degrees above the boiling point without boiling taking place. A piece of flint immersed in a liquid was alive with bubbles over its entire face until broken in two, when no steam was given off from the freshly formed surface. The introduction of iron filings caused rapid ebullition. Substances over which water is most reluctant to spread, that is, those solids which show the least adhesion for water, furnish the greatest number of nuclei. One paragraph from a paper by Lord Rayleigh,²² where he discusses 'Liberation of Gas

¹⁹In using 'affinity' and 'capillarity' I am only attempting to use terms that we have all used when discussing amalgamation.

²⁰Thomas T. Reed, Trans. A. I. M. E., Vol. 37, says that amalgamation is a physical rather than a chemical process; that the sur. ten. of mercury draws the gold beneath the surface.

²¹Theoretical and Physical Chemistry, p. 247.

²²Philosophical Magazine, Vol. 48, 1899.

from Super-saturated Solutions,' is sufficient to show the close relation between boiling and flotation. He says: "It seems to me that Tomlinson was substantially correct in attributing the activity of non-porous surfaces to imperfect adhesion. We have to consider in detail the course of events when a surface, for example, of glass, is introduced into the liquid. If the surface be clean, it is wetted by the water advancing over it, whether there be a film of air condensed upon it or not, and no gas is liberated from the liquid. But if the surface be greasy, even in a very slight degree, the behavior is different." In another book²³ we learn that "metal turnings depress the boiling point because their molecular attraction for water is less than that of glass."

We have ample evidence, therefore, that solids, like fresh quartz over which water spreads freely, do not carry nuclei of air, while solids like galena, over which water does not spread freely on account of adhesion, do have small bubbles attached to them while submerged in water. For an extreme case where air nuclei would be present, we might suppose a glass sphere to be submerged in mercury. As it passes below the surface with

which is inflated with air and expelled gas. I wish to express my gratitude to Dr. Joel H. Hildebrand for his critical reading of these notes and for his assistance during the seminar in 'Colloids and Surface Tension' at the University of California. Also I wish to thank H. M. Parks and Ira A. Williams of the Oregon School of Mines for their co-operation.

Explosives

Explosives as used in mines are discussed by E. M. Weston of Johannesburg, in his recent little book 'Practical Mining on the Rand.' This book was written for the purpose of explaining to shift-bosses and miners the things they should know about rock-drills, explosives, stoping, development, and similar subjects. The author is manager of a mine on the East Rand. Of so practical a description are the contents of the book that the Transvaal Chamber of Mines purchased 3000 copies for distribution among underground employees. The miner's work is dependent on the proper use of explosives, and if this is not understood, bad results are sure to follow. Explosives are of two kinds; slow or rending, such as gun-powder; and high or quick, such as dynamite. Gun-powder or black powder, when exploded, changes into gas in one-hundredth part of a second. One part of the powder makes 1500 to 2000 volumes of gas, and exerts a pressure of 11 tons per square inch of rock. On the Rand, high explosives are commonly used. They turn into gas much more quickly than black powder, taking only one twenty-thousandth to one fifty-thousandth part of a second. One volume of high explosive makes 16,000 volumes of gas, which exerts a pressure of 117 tons per square inch of rock. This is a force over 10 times more powerful than black powder. The high explosives include straight dynamite, gelatine dynamite, gelignite, and blasting gelatine. Nitro-glycerine forms the chief constituent of all four. It is a thin oily liquid, of specific gravity $1\frac{1}{2}$. Straight dynamite is nitro-glycerine absorbed in diatomaceous earth or some similar neutral base. Gelatine dynamite contains also nitro-cellulose with potassium nitrate, and wood-meal. It is 25% stronger than straight dynamite. Gelignite is a mixture of nitro-glycerine, nitro-cellulose, potassium nitrate, and sawdust. It is 12% more powerful than dynamite. Blasting gelatine contains about 93% nitro-glycerine, which forms a jelly by combination with an extract from gun-cotton. It is 50% stronger than dynamite. Nitro-glycerine begins to evaporate and exude from an explosive at 110° F. Any explosive in this condition is dangerous to handle, and should not be used, but destroyed. Frozen explosive should be thawed before using, as otherwise it will not detonate properly and is likely to explode from rough handling. When a man has been overcome by nitrous oxide gas resulting from an explosion, it is a mistake to carry him out at once. The first effort should be to reach the air-cock and turn on the air, or break the pipe with a hammer. The sufferer should be held in the escaping air, thus gaining time.

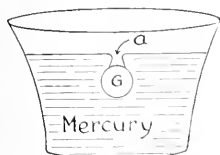


FIG. 16.



FIG. 17.

its angle of contact of 140° , it would appear as shown in Fig. 16.

With the disappearance of the waist at *a*, the film closes around an air nucleus. A small quantity of air would thus be carried down and if the mercury were transparent, one could see an air bubble attached to the glass. A fresh piece of glass in water would not do this, for the water would close over it as shown in Fig. 17. But we do not have to go so far afield to account for attached air-bubbles. The surface of all minerals contain depressions and it would be impossible for them to pass from air to water without some of the air residing in the depressions being carried below the surface. Whether or not the air is held in place depends on the adhesion of water and mineral. If adhesion is less than cohesion of the liquid molecules, the surface film will pass around the air nuclei and hold them in place, but if adhesion is great the water will spread over the entire surface of the mineral and ultimately release the air bubbles. The application of these principles to flotation is simple: minerals with the least adhesion for water will retain the greatest number of small bubbles; these bubbles are inflated by gases expelled from the solution; and finally an air-bubble in its passage impinges against, and coalesces with, the attached bubbles and the mineral is carried to the surface by the resulting bubble.

²³'Theory of Heat,' Preston.

Buying Supplies for a Mine

By Nelson Dickerman

One of the most important problems for the management of mining enterprises in foreign countries is the proper maintenance of warehouse stocks. Supplies of all kinds that might be necessary and in sufficient quantity to meet every demand must be kept on hand. And these demands must be anticipated, often as much as six months, so as to have the goods on hand when needed. At the same time the management must not invest in supplies any more money than is absolutely necessary for this purpose, as this money is totally unproductive. Perhaps a few notes concerning my experiences in such matters while in Colombia will be of interest.

We could depend but little on the local market in Colombia and what supplies we got in the country were bought at such an advance in price over that of the same article from abroad, that we did only a small percentage of our trading there. Our nearest market was New York, and it took from three to four months from the writing of an order to the receiving of the material. Even by cabling, to which we sometimes resorted in case of great necessity, it took from a month to six or seven weeks to get the goods.

In ordering, it was very important to state precisely and accurately what we wanted, how it was to be packed, and how shipped. At this point I shall digress and state that the United States will never be able to supplant England and Germany to any large extent until exporting houses learn how to fill orders accurately, pack properly, mark packages in the language of the country to which they are consigned, and make out correct bills-of-lading and consular invoices. Many of the houses here think their duty to their foreign customers ends with the filling of the order and getting it off their hands. But unless the goods arrive in a satisfactory condition and with the least amount of expense and bother to their customers, they have failed in the performance; and this means a dissatisfied customer. Perhaps it will be well to run over the various phases of ordering and receiving supplies in the hope that there may be a point here and there that will help someone who is undertaking this duty for the first time under similar conditions.

Our warehouse and supplies were administered under as accurate and thorough a system as we would maintain at home. A card-index of supplies was carefully kept, and checked whenever possible. Any extraordinary demands were anticipated as far as possible by keeping in touch with the foremen of the different departments; in fact, it was only by the closest co-operation of all departments that we never had to shut-down for want of material or tools that we could not improvise on the ground.

The supply-man had to be more self-reliant than on a

similar job in the States. He endeavored to keep on hand a complete file of catalogues and descriptive matter. Frequently the need of some new tool or device would find him without the proper catalogue; or the need of some part of electrical or pump machinery that was not a common stock article would find him without proper descriptive matter. He could not order a thing on trial, as the customs and transportation charges would not permit the returning. Nor could he afford to take the chance that the people from whom he ordered would understand better than he did what was wanted. The chance of a mistake might mean the having to wait for the proper fulfillment of the order from four to six months. He had to be sure of what he was ordering and whether the article, if a new one, would be satisfactory under the peculiar climatic conditions. In sending an order it was necessary to give full directions for marking and shipping. And often after some particularly bad luck we would append packing directions to our next order or the correct way of making out consular declarations.

Under packing troubles we had a number of complaints to make. Here are a few as they recur to me. Under the custom duties of Colombia, the tax is not charged on the net weight of an article only but on the container and packing as well. We ordered a high-grade smoking tobacco from one of the largest distributing houses in New York, asking them to pack it as lightly as possible in tightly strapped boxes. This tobacco comes in half-pound vacuum-sealed tins. It was sent to us two tins each in heavy porcelain jars, the latter a generous gift, packed in a heavy wooden box. As tobacco pays one of the highest duties in Colombia, this tobacco, which retails here at \$2.25 per pound, cost us \$14.91 per pound to land in our store, and no one could afford to buy it. On several different orders we requested this same house to remove the heavy wooden caddy from chewing tobacco and wrap the tobacco in oiled paper, but they never complied with our request and we finally had to have the tobacco sent to a hardware firm who re-packed it for us as we desired.

Another and more costly packing was used on the order of some dredge-bucket pins. These pins, weighing almost 200 lb. apiece, were packed, ten together, in a heavy two-inch plank case, which made the weight over a ton to a box. Not only did we have to pay the custom duties on these boxes but we had to pay the extra tariff on river-steamers for the extra weight. This on boxes or crates weighing 500 kilo amounted to 25% extra; 1000 kilo to 50%, and so on up, in addition to the regular rate. These forged pins could have been shipped loose, saving all that.

It is well for exporting houses to understand the ocean tariffs in regard to space and weight extras, and purchasers should give the local river and transportation tariffs so that goods can be packed in packages of the most economical size, assuring the lowest rates. We ordered a lot of window and plate glass from a firm in the United States three times and out of over one hundred pieces we did not receive half a dozen pieces unbroken in the three shipments. We had carefully gone over the result of the arrival of each shipment in letters to the firm supplying the same, and even made suggestions as to the way we considered it best to pack the glass, but all to no purpose. Finally we placed the order with a German firm and received it without a single broken piece.

By the above examples I do not mean to advocate a light boxing or a sparing of packing material. It all depends on what is being sent. Some goods can be sent wrapped only in burlap when there is no danger of crushing or breaking; and if liable to be injured by water, further protection is obtained by using waterproof paper. But in the case of delicate machines or electrical apparatus, the utmost care must be taken in packing. One must have the idea constantly in mind what handling the goods will undergo before reaching their destination. The journey from the warehouse to the docks is usually not hard. Here the ships take the different boxes, crates, and parcels in rope-slings and drop them into the hold, often with quite a shock. If a light crate happens to be on the bottom, under heavy boxes, it is apt to be damaged. The storage on the voyage is not likely to produce much damage; but the unloading is again attended with danger. The captain is usually in a hurry to clear his hold and the slings are filled, hoisted, and dropped with all possible speed. At Puerto Colombia the goods from these slings are loaded immediately on freight-cars and run up to Barranquilla, a distance of 18 miles, to the custom-house. Here they are unloaded and inspected. When reloaded, they are taken in carts to the yards of the river-steamboat company and dropped off the carts upon the ground. And here it may be well to say that any sign in English, such as "Glass," "This Side Up," or "Handle With Care," is unintelligible, and totally disregarded. If in Spanish, it meets with but little more consideration. It is only by being on the spot and with constant nagging that you can in any way protect your goods. I do not mean that these signs should not be put on the cases; they should be inscribed in both languages, but the packing should be done with such skill that even after all possible hardships the articles enclosed will arrive safely at their destination. The loading on the river boat is all done by hand, using block and tackle or a steam-capstan. The smaller packages are dumped into the hold and rolled into place; the larger ones are put on deck or on barges to be towed. The voyage of 370 miles up the river is usually not hard on the cargo, except that some of the boxes on the barges may be thoroughly wetted and sometimes those in the hold are similarly treated. In the dry season all the

goods will be dumped on the bank if the boat is unable to reach its destination, to wait there until the river rises and the boat again reaches the spot. We had several experiences of the river coming up and flooding goods left on the bank high above low water, but not above the flood-level. When the goods reached us we were able to unload them by derrick and see that they were handled rightly. But the damage, if any, had been done before their arrival.

The best practice in the packing of small articles, it seems to me, is to put them in packages of around 100 to 150 pounds weight. These can be carried easily and the carriers are not given the incentive to drop them. In the packing of such articles as bolts the tendency is to put them in cases weighing from 300 to 400 lb. and these cases we often received badly damaged, or with some of the contents missing.

In this connection I am reminded of the cases of petty pilfering that used to annoy us, especially in the matter of food supplies. A can or two from a case would be missing. The condensed-milk cases suffered especially. Sometimes the cans would be punctured, the contents removed, and the can replaced. Often too the cans would be damaged in the rough treatment received and the contents spoiled. This might be due to the cases being too lightly constructed, allowing the cans too much movement. Especially was this true of the gallon-cans of fruit that often arrived in poor shape. We had to give up the use of these large cans and use the smaller sizes. However, if the exporter would have his fruit put up in heavier cans and more solidly constructed cases than are used for domestic consumption, this would not occur. The English are far ahead of us in putting up food supplies for tropical countries, in great measure due to the large trade they have had for many years with India. We have ordered dried fruits put up in sealed tins from one of the large New York houses and they came in screwed-top tins. The moisture and heat soon spoiled a good part of the contents.

In the movement of heavy machinery there are many difficulties to overcome. I remember a punch and shears we ordered that when crated weighed 13½ tons. The only trouble in handling this piece was from the railroad-car to the river-boat, a distance of not over a hundred feet, but it took 70 men 10 days to get it off the car and on the boat. The extra freight for excess weight on the machine was horrible, as I remember it, about 400% of the regular ton weight. We unloaded this easily with our derrick, but it would have been impossible to have taken it up to some of the mines in the hills. In this respect manufacturers should carefully consider the sectionalizing of machinery for mule or other transport into localities requiring it.

Returning to the extension of our trade with foreign houses, it seems to me there are certain rules that must be followed if we are to keep this trade.

(1.) The catalogue, which is the first introduction to the new customer, should be compiled carefully and accurately for the country in which it is to be used and in the

language of that country. It should fairly and in full detail describe the articles to be sold, giving the weight, net and crated, for export shipment; if for large machinery, the weight and size of the largest piece should be stated. Prices and all charges, terms of payment and delivery, should be fairly set forth. If discounts from these prices are given and these must be written for, this should be stated clearly.

(2.) Correspondence: The first letter of inquiry should have personal attention given to it and the endeavor made to establish a personal relationship. If orders follow this, personal interest should be extended and continued in the hope of making a confirmed customer; especial attention should be accorded to complaints.

(3.) Packing: The directions for this should be fully given and carried out.

(4.) Bills-of-lading and consular invoices should be carefully prepared, filled out, and forwarded promptly with invoices and packing-lists. Also in the case of machinery, instructions and blue-prints should accompany the letters. Of course, all this must be made out in the language of the customer.

(5.) A request should be sent to the customer with every shipment asking him to write on receipt of goods, stating the condition of the goods on arrival and whether perfectly satisfactory. Also asking him for suggestions as to any means he might propose in which better service could have been given, this for reference in future shipments. A regular form-card could be sent for this purpose, and it should be checked on return and filed for future shipments.

By such a system I believe we could establish a foreign trade based on such honesty of goods and service that other nations would find it hard to take it from us. It is not altogether a question of price. We must learn to do business in the way of our customers and to gain their confidence. We cannot know them without living among them and understanding their conditions. And only by knowing them and establishing a common bond of dependence, can we hope to keep their trade. And above all, our Government must encourage and protect young men going into foreign countries and working there to advance themselves and American trade.

Belt-Conveyors

For moving material supplied in a continuous stream, a belt conveyor is well adapted. The capacity of a narrow belt is surprisingly high in consequence of the speed at which it may be run. Reginald Trautschold, writing in the *Engineering Magazine*, gives the most economic speed for various materials handled by belt-conveyors. Coke is best conveyed at 250 ft. per minute. Coarse broken stone and lump coal should also have low speeds, about 275 ft. per minute. Fine coal, however, is best handled at the high speed of 400 ft. per minute. Sand or gravel and ordinary crushed stone, are conveyed most economically at 375 ft. per minute. A belt-

conveyor 1 ft. wide can handle nearly 90 tons of sand per hour, while one 3 ft. wide has a capacity of 800 tons per hour, or nine times as great, in each case run at a speed of 375 ft. per minute. These figures apply only when conditions are working perfectly. The power requirement of belt-conveyors is low. A 30-in. belt, when working at most economic speed, can handle 270 tons of fine coal per hour, elevating 20 ft., and distributing the coal by an automatic tripper over a 50-ft. storage-bunker, at a requirement of $13\frac{1}{2}$ hp., of which $5\frac{1}{2}$ hp. would be needed for the horizontal travel, $5\frac{1}{2}$ for elevating the load, and $2\frac{1}{2}$ for the tripper, the conveyor being equipped with grease-lubricated idlers. If ball-bearing idlers are used, the power consumed would be $11\frac{3}{4}$ hp., the reduction of $1\frac{3}{4}$ hp. being principally the saving in friction on the horizontal travel.

The best grade of rubber is none too good for a conveyor, as its large capacity makes initial cost secondary in importance to that of wearing quality. The labor charge for inspecting and repairing conveyors is generally taken at $1\frac{1}{2}$ c. per hour per inch of width. The cost for grease and incidental supplies varies directly with the horse-power consumed, and averages $\frac{1}{2}$ c. per hp. per hour. Depreciation of a belt comes from hardening of the rubber, and is more apt to follow idleness than careful use. Ordinarily, an annual depreciation charge of 25% on the belt covers the wear and tear. The net operating cost on an 18-in. belt-conveyor, 500 ft. long, handling 85,000 tons of fine coal at a rate of 85 tons per hour for 1000 hours per year, was less than 2c. per ton. This conveyor elevated the coal 30 ft. and distributed it over a bunker 100 ft. long by means of an automatic traveling tripper, power being furnished at 2c. per hp.-hour. The speed was 400 ft. per minute; the power was 14 hp. (11 hp. if roller-bearings are used); the initial cost of equipment was \$3720; depreciation was charged at \$710 per year; annual fixed charges were \$316; labor cost \$270 per year; and power cost \$280 per year.

When a large quantity of material has to be handled at a rapid rate in a limited space, and the cost for power is not so important as the initial investment, flight-conveyors may be used. While their speed is slow, the load per foot is high. The best advisable speed is 100 to 200 ft. per minute. A horizontal flight-conveyor, 8 by 18 by 16 in., 150 ft. long, handling 150,000 tons of fine coal in 600 operating hours, the power costing 2c. per hp.-hour, would have a net operating cost of 0.8c. per ton. The advisable speed would be 200 ft. per minute; the capacity 260 tons per hour; the power required would be $31\frac{1}{2}$ hp., costing \$378 per year using shoe-flights, or 28 $\frac{1}{2}$ hp., costing \$342 per year using roller-flights; the initial cost of equipment would be \$655 with shoe-flights or \$880 with roller-flights.

Screw conveyors have comparatively a limited capacity and a high consumption of power. They are particularly well liked for handling cement. Though cheap in first cost, the depreciation is rapid; the screw revolving in the load receives destructive abrasive action. The economic speed is governed by the diameter of the screw,



NEDERLAND: ONE OF THE BOULDER COUNTY TUNGSTEN TOWNS.

Tungsten in the Boulder District, Colorado

By E. H. Leslie

In the year 1870, Sam. P. Conger, prospector and pioneer, in going over the hills of Boulder county found a heavy, dark mineral which occurred as float. The true nature of this mineral was a mystery to Conger and others, to whom it became known as 'heavy iron,' 'hematite,' 'black iron,' or 'barren silver.' It was considered to be of little commercial importance until many years later when a prospector, W. H. Wanamaker, a partner of Conger's, returned from a prospecting trip in the Dragoon mountains of Arizona, where he came across similar mineral. This he ascertained to be ferberite, the tungstate of iron. Wanamaker and Conger kept the matter secret, making every effort in the meantime to secure possession of some of the placer tungsten and vein deposits of Boulder county. In August, 1900, Conger secured a lease on the property which is now known as the Conger mines in the Nederland district, and by the end of that year extracted about 40 tons of high-grade ore. In 1901 the production amounted to 65 tons, which was marketed at \$2.25 per unit. In 1902 there was a decided slump, making operating conditions unfavorable. From that time until about a year ago, the mining of tungsten ore in Boulder county was spasmodic and of comparatively little importance, although interest in the district was kept alive and considerable prospecting was done. Within the last year a decided revival in interest in tungsten has taken place by reason of the abnormal market conditions for tool steel and other uses to which it has been found so well adapted.

The principal part of the tungsten district of Boulder county is the south-eastern quarter. The latest geologic maps show that the tungsten mining area has a general north-east and south-west trend, dipping down into Gilpin county on the south, where some important discoveries have been made. The principal towns in the district are Nederland, Cardinal, Phoenixville, Rollinsville, Sugarloaf, and Magnolia.

Most of the mines are found in the granite, gneissoid granite, and the more granitic parts of the gneiss. A number of the properties are situated close to the contact of gneiss and granite; in some places the workings are almost entirely within the gneiss. In the Nederland-Beaver Creek area, a number of veins follow the dikes of coarse and fine pegmatite, but the relationship is due to structure rather than to any common genesis. The fissuring now occupied by the veins, which were long subsequent to the formation of the pegmatite dikes, followed the lines of least resistance, which in several places coincided with the dikes. Other veins are associated with a fine-grained intrusive biotite-granite which forms dikes and irregular masses, such as that at the Clyde mine, a mile north-east of Nederland. In some cases the vein leaves the dike entirely and passes out into the neighboring formation, usually at a sharp angle with the dikes. In the north-western area, the long line of mines and prospects roughly parallel to middle Boulder and Boulder creeks, near Castle Rock, is closely associated with a narrow but rather continuous dike of

fine-grained granite. In places the entire width of the dike is occupied by the vein. There is no regular system of veins, but in the Nederland and Beaver Creek area a great many strike north-east and south-west. Few have a strike west of north. The average strike of 11 well-defined veins in the western part of the Nederland-Beaver Creek area is north 32° east. The angle of dip of the veins is generally steep, often approaching the vertical and rarely falling as low as 45° .

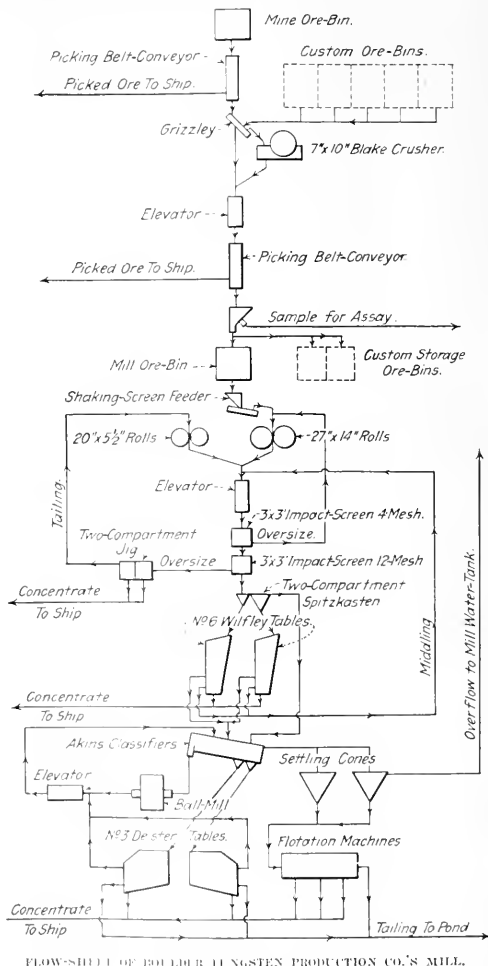
For further details of the economic geology of these tungsten deposits I suggest a study of R. D. George's monograph entitled 'The Main Tungsten Area of Boulder County, Colorado.'

In Boulder canyon the mines are generally worked through adits by over-hand stoping methods, with raises and open stopes requiring little timber. The veins as a rule dip at a steep angle of from 75° to 90° and the strike is generally north-east and south-west. Some of the larger operators have power at the mines for drilling, but single and double-jacking methods are responsible for a great part of the output. In some instances miners are working from the outcrops by open-cut methods. In the vicinity of Nederlands the mines are generally worked through shafts, the deepest of which, at the Conger mine, is down 1160 ft. Others in the district are from 200 to 400 ft. deep. The water problem is comparatively insignificant. The average ore contains from 1.5 to 2.5%, although ore has been found in quantity averaging as much as 35% tungstic oxide (WO_3).

Milling practice closely follows standard wet concentration methods, although these have been amplified to meet more fully the requirements of the ferberite. In early work on this ore it was found that a good deal of the tungsten-content was contained in the slime, and as such, in the ordinary milling methods, the greater part of the loss occurred in this division of classification. To meet this loss, it has been found that rolls or mills of the Chilean type are better adapted for crushing than stamps, due to their making less slime and a better product for jigs and tables. It may be said that excellent work is being done at the Wolf Tongue plant, which is an old re-modeled stamp-mill. As supplementary to regular milling there have been added 'rag-mills' or stationary canvas tables, which have increased the recovery materially. The mills are generally of from 15 to 25 tons' capacity daily, although on another class of ore and with the same equipment they would undoubtedly treat a much greater tonnage. It has been found that it is impossible to crowd the mill in treating tungsten ore, without a decided reduction in the extraction. When I say that the mills are making an average recovery of from 89 to 91% of the tungsten content of the ore treated, I am quoting several of the superintendents and operators of the larger mills. A good deal of the ore treated is that from small operators and lessees. The concentrate averages from 60 to 65% WO_3 .

The Clark mill of the Boulder Tungsten Production Co., situated just east of the big Nederland dam in what is known as Stevens Camp, is representative of the most

modern practice for the treatment of the local ferberite ore. This plant, which was built at a cost of \$25,000, commenced operation at the beginning of 1916, and it was said that its entire cost was repaid by the first month's profit. The mill was designed by Randall P. Akins of the Colorado Iron Works Co., which company supplied all equipment and superintended its construction. It was designed as a 30-ton mill, and was working



FLOW-SHEET OF BOULDER TUNGSTEN PRODUCTION CO.'S MILL.

90 days after the contract was signed. The accompanying flow-sheet shows the process employed. The final residue is passed over stationary canvas-tables or a rag-mill not shown in the flow-sheet. The flotation machines shown in the flow-sheet were not installed at the time of my visit, but plans were being prepared for a thorough investigation of the adaptability of flotation as a supplement to milling, with special reference to the slime product, which is at present being treated on tables and in the rag plant.

The ore treated varies from 0.5 to 2%, giving an extraction of about 90%. The mill is driven by three electric motors, supplied with current by the Colorado Central Power Co.; about 50 hp. is required for the entire plant.

The following is an outline of the treatment at a few of the other mills in the district:

At the Wolf Tongue, which is one of the oldest here, machinery consists of a jaw-crusher, stamps, jigs, Wilfley and Card tables, Monnell slime-tables, classifiers, and stationary canvas-tables or rag-plant. The flow-sheet has been undergoing many changes lately, but the work done is said to be highly satisfactory.

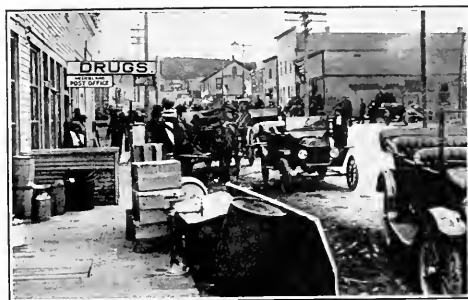
The Lucky Two Tungsten Co. has been treating tungsten ores since 1910. Its equipment consists of two Denver quartz mills, two pairs of 12 by 20-in. rolls, jigs, Wilfley tables, Monnell slime-tables, and rag-plant. The mill is treating 25 tons daily.

At the Duncan mill, at the Black Prince property, there is an 8 by 12-in. Denver crusher, Denver quartz mill, 12 by 20-in. McFarland rolls, Richards' jig, two Wilfley tables, two Monnell slime-tables, a rag-plant and accessories.

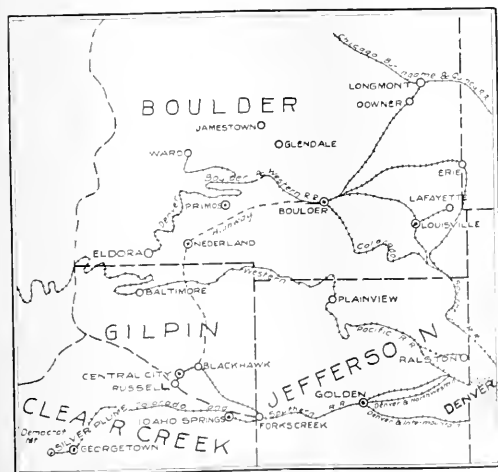
The mill of the Tungsten Mines Co., between Nederland and Rollinsville, on Beaver creek, has been in operation since 1910, and has similar equipment to that mentioned above. The Red Sign mine of the Primos company will erect shortly a mill following general practice.

far show that there it is probable that flotation will find a place in the treatment of ferberite ores.

The trip from Denver to the tungsten district, a distance of 60 miles, is generally made by automobile. That there is a mining boom in Boulder county is advertised on the street corners of Denver by display placards on automobiles, in hotel lobbies, by groups of mining men discussing the strength or weakness of the tungsten market, and in offices of the machinery manufacturers, who are being called on to meet an abnormal market for all



STREET SCENE AT NEDERLAND.



MAP SHOWING SITUATION OF TUNGSTEN FIELD.

The Ross and Foley is another of the representative mills of the district.

Some experimental work is being done at the Wolf Tongue mill of the Vaseo company to determine the applicability of flotation to the Boulder County ores. It is also proposed, as stated, to experiment with this process at the Clark mill. While tests have not progressed to a point that will warrant a definite statement, results so

far show that there it is probable that flotation will find a place in the treatment of ferberite ores. It is not at all unusual to hear of a mill being constructed in two or three months and paying for itself in an equal length of time. The road to Boulder, on an early Sunday morning especially, is crowded with machines, trucks, and wagons laden with sight-seers, miners, equipment, and all that goes into the making of the mushroom growth of a boom community. At Boulder, where a stop is usually made before entering the canyon, the streets are filled with a heterogeneous collection of people and conveyances. Beyond and through the canyon one continuous stream of motor-cars pours its burden through the gulches and over the precipitous mountain road into Nederland. The trip is punctuated with trucks and cars that have gone over the embankments and others which have been unable to make the grades. Nederland, like Oatman, Arizona, is a dry camp and as a result, the movies and soft-drink emporiums are the sole diversions, while a greater amount of miners' and lessees' earnings are going into drill-steel, dynamite, and savings accounts. The streets, or more properly street, is congested with people and traffic, and the landscape presents the appearance of a national guard encampment with the numerous tents, commissaries, bunk-houses, pine lumber, and unpainted buildings, which spring up almost over night. At the time of my visit, during May, the town had grown from a population of about 500 six months ago to one of about 4000 people.

VALUE of copper, lead, silver, and zinc produced in the Central States during 1915 was \$121,283,262, an increase of 120% compared with that for 1914, this being principally in zinc and copper.

Atmospheric Humidity and Its Measurement

By Kenneth G. Smith

*The large number of deaths from heat in the Eastern States recently has drawn attention to the excessive humidity of the atmosphere, which was registered on one day as 70%. Humidity in mine air is also an important problem. According to the law of partial pressures, commonly known as Dalton's law, two gases at the same temperature do not interfere with each other's pressures when mixed, provided there is no chemical action. Each one exerts the same pressure that it would at the given temperature if the other were not present. The total pressure is the sum of the pressures of the two gases. Experiment shows that this law holds good for a mixture of gas and vapor such as water-vapor and air. Taking water-vapor and air as an example, if P_a is the air-pressure and P_o the vapor-pressure, then $P_a + P_o = P_t$ = total pressure of vapor and air. If the vapor is saturated, the temperature of the mixture is definitely fixed at the saturation temperature corresponding to the pressure P_t . If the temperature is higher than the saturation temperature at the given pressure, the vapor is superheated. Water-vapor in the atmosphere is superheated except on damp, foggy days, when the water-vapor is saturated, or as we say, the air is saturated with moisture.

The weight of a cubic foot of superheated vapor is less than the weight of a cubic foot of saturated vapor. If m_1 is the weight of a cubic foot of saturated vapor, and m_2 = weight of a cubic foot of superheated vapor at the same temperature, then the ratio $\frac{m_2}{m_1}$ expressed in per cent is called the humidity of the air containing the vapor; that is, it is the ratio of the moisture actually contained in the air to that which the air could contain at that temperature if saturated.

If a mixture of air and superheated vapor is cooled at constant pressure (say atmospheric pressure), it will finally reach a point where the vapor becomes saturated instead of superheated, and further cooling results in condensation. The temperature at which condensation begins is called the dew-point. This is simply the saturation temperature for the given pressure. The gas law $PV = \text{constant}$, which we may assume holds good for low-vapor pressures, gives us the means of calculating the ratio $\frac{m_2}{m_1}$ already referred to as the humidity.

Let P_1V_1 represent the condition of saturated vapor at the given temperature, and P_2V_2 its actual condition at this temperature—that is, in its superheated state. Then

$$P_2V_2 = P_1V_1 \text{ and } \frac{P_2}{P_1} = \frac{V_1}{V_2}$$

If the vapor is cooled at a constant pressure P_1 down to the saturation temperature—that is, to the dew-point—

then since P_2 is unchanged the ratio $\frac{P_2}{P_1} = \frac{V_1}{V_2}$ still holds good; now substituting for the volumes per cubic foot, their reciprocals, the weights per cubic foot, $\frac{P_2}{P_1} = \frac{m_2}{m_1}$.

Hence, the humidity in per cent is equal to the ratio of the pressure, corresponding to the dew-point, to the saturation pressure, corresponding to the temperature of the mixture. An example will make this method of measuring humidity clear. Suppose that air has a temperature of 70°, and the dew-point is found to be 50°. What is the humidity and weight of vapor per cubic foot? From a table of vapor-pressure we find that at 55° the saturation pressure is 0.436 in. of mercury. At 75° the saturation pressure is 0.8735 in. of mercury.

The humidity is then $\frac{0.436}{0.8735} = 50\%$, nearly. If the air were saturated at 75°, it would contain 9.36 grains of moisture per cubic foot. Hence, at 50% saturation it contains $9.36 \times 0.5 = 4.68$ grains per cubic foot.

To measure moisture in this way would be difficult under other than laboratory conditions, and for that reason another method, using a wet and a dry-bulb thermometer, has been adopted. The dry-bulb thermometer is simply an ordinary Fahrenheit thermometer. The wet-bulb instrument is exactly the same except that it has a piece of muslin or other porous material wrapped around the bulb and saturated with water. When both are exposed to the air, the wet-bulb thermometer immediately falls to a lower temperature than the other, owing to the fact that the evaporation of the moisture in the cloth requires heat. The drier the air the more the evaporation and the greater the drop in temperature. From the difference in temperature between the wet and dry-bulb thermometers the humidity may be calculated. In practice it is not calculated, but read directly from a table or curve.

One might naturally ask the reason for the fixed temperature to which the wet-bulb thermometer drops. This temperature is known as the temperature of adiabatic saturation, and is fixed for any dry-bulb temperature and percentage of humidity. To understand this statement, imagine three thermometers placed in a body of air to which moisture is to be added without exchange of heat with any source outside of the air and water. The first thermometer is arranged to show the dew-point and reads the lowest. The second or dry-bulb thermometer shows the dry-bulb temperature or, as we call it, the temperature of the air. The third thermometer shows a temperature between the dry-bulb temperature and the dew-point. Take, for example, air as 70° and 33% saturated. Then the conditions are as follows: dry-bulb temperature, 70°; dew-point, 39°; wet-bulb temperature, 54°.

If now a fine spray of water having a temperature higher than 39° is introduced, the air absorbs moisture, with the result that the dry-bulb temperature drops at once, the dew point temperature rises and the wet-bulb temperature remains stationary. The reason is that the total heat of the air is constant. The heat required to evaporate the moisture is rendered latent, and the sen-

*Abstract from *Compressed Air Magazine*, originally published in *Iowa Engineer* of Iowa State College.

sible heat as shown by the dry-bulb thermometer becomes less, but the sum of latent and sensible heat is constant. If moisture continues to be added, the dew-point temperature continues to rise, the dry-bulb temperature continues to fall until all three are stationary at the wet-bulb temperature, when the air is saturated. The total heat of the air is the same as it was before the moisture was added, but it contains more latent and less sensible heat. On the total heat the wet-bulb temperature depends, and therefore it is fixed for any temperature and percentage of humidity, because the total heat of the air in the given condition is fixed.

In the example given the percentage of humidity may be calculated if we know the dry and wet-bulb temperatures. These are as given, dry-bulb 70°, wet-bulb 54°. The temperature of adiabatic saturation is 54°, and at

this temperature the air contains 62.14 grains per pound when saturated. The total heat of the mixture equals the heat of the air plus the heat of the moisture, or

$$0.2375 \times 54 + \frac{1084.7 \times 62.14}{7000} = 22.44 \text{ B.t.u.}$$

Since the total heat of the air is constant during the change, the total heat at 70° equals the total heat at 54°, or

$$0.2375 \times 70 + (1084.7) + 0.48 \times 16 \times X = 22.44$$

X = Grains of moisture in air at 70°.

0.48 = Specific heat of the vapor.

Solving for X , we have $X = 37.2$ grains per pound of air.

Since saturated air at 70° contains 110.01 grains per pound, the humidity is $\frac{37.2}{110.01} = 33\%$.

Jig Concentration in Joplin District, Missouri

By Clarence A. Wright

*The most common type of jig used in this district is known as the Cooley, which is similar in principle to the Harz. It is of the fixed-sieve type, the water being forced up and down through the screens or grates by the action of a plunger placed in an adjacent compartment. The number and size of the compartments for each jig depend on the size and character of the ore treated.

In general, a system of 'roughing' and 'cleaning' is followed in which the feed is given a preliminary cleaning that eliminates the greater proportion of waste material on one or two rougher-jigs and the enriched product, which will assay from 14 to 18% zinc, is cleaned on a cleaner-jig for the final treatment, bring-

ing the zinc tenor up to 55 to 60%. The 'chats' or included mineral particles from both the rougher and the cleaner-jigs, which together will assay 4 to 8% zinc, are re-crushed, and either returned to the rougher-jig feed or treated separately over a chat-jig. The tailing from the rougher-jig is dewatered by means of a trommel with $1\frac{1}{2}$ to 2 mm. openings, over the outside of which the tailing passes as the trommel slowly revolves. The undersize from this dewater-screen flows to settling-tanks and the oversize to the tailing elevator as waste. The overflow from the tailing-end of the cleaner-jig and other jigs, if used, also passes to the settling-tanks for subsequent treatment.

The rougher-jigs usually consist of 5 to 6 cells with a screening or grate-area of 30 by 42 in. to 36 by 48 in. The speed of the shaft connecting the plunger and eccentrics varies from 90 to 120 r.p.m., with the length of the stroke of the plungers ranging from $\frac{5}{8}$ to $1\frac{1}{4}$ in. The cleaner-jigs have 6 to 7 cells with a grate-area somewhat smaller than that of the rougher-jig. The speed of the shaft connecting the eccentrics and plungers is from

*Abstract from *Joplin Globe*.



NEW TYPE OF JIGS IN TAILING-MILL AT CHITWOOD, MISSOURI.

160 to 200 strokes per minute, with lengths of stroke ranging from $\frac{3}{8}$ to $\frac{3}{4}$ in. The chat-jigs, which are not commonly used, are smaller and usually consist of 4 to 5 cells, and are operated at a higher speed and shorter stroke.

The material fed to the first cell of the jig is, as a rule, not graded or classified. A bed, 5 to 6 in. deep, is formed, and as a result of the pulsating action of the water the lighter gangue material, such as flint, settles on the surface, the heavier free grains of lead and zinc working to the bottom. The downward suction-stroke causes the finer grains of minerals to continue through the screen or grate-openings into the hutch of each compartment. The strength of the suction-stroke is increased by leaving the gates of the hutch partly open. The accumulation in the hutch is known as 'smitten,' and is further treated on the cleaner-jig. The bed products of the first two or three cells are also drawn-off and pass, together with the hutch-product, to the cleaner-jig. The chats or included mineral particles, usually from the last hutch and the last two or three beds, are drawn-off and re-ground before further treatment.

It has been found from various tests that a few minor changes in the flow-sheet or treatment of the ore would seem feasible to effect more efficient jigging and to make a greater saving possible.

The feed to the rougher-jig, which in most cases is ungraded material, consists of both coarse and fine material. In the treatment of a sheet-ground ore we find that 3.25% of the feed to the rougher-jig consisted of material finer than 200-mesh, with a zinc-content of 5.77%, which represented 1.72% of the total zinc in the feed. Also the screen analyses of the tailing before it was dewatered, show that the assay-value of the material finer than 200-mesh was 4.50% zinc, indicating that a small recovery was made on this size material as it passed over the jig. The percentage of material finer than 200-mesh in the tailings was 3.62, which represented 32.26% of the total zinc in the tailing. Screen analyses of the dewatered tailings showed that there was still 1.09% of the material finer than 200-mesh contained in the tailings, with an assay value of 4.20% zinc, which was discarded.

It is reasonable to believe from the above figures alone that it would be advisable to de-slime at the head of the rougher-jig. However, the importance of de-sliming is more strongly emphasized by the fact that the dewatering screens as used at the end of the jigs in this district are, as a rule, not very efficient, which means a loss of fine mineral in the jig-tailing. To show this more fully the efficiency of the dewatering screen at the end of the rougher-jig was determined. It should be stated that the object of the dewatering screen is not to eliminate the water from the tailing, but to collect as much of the fine as possible from the tailing overflowing at the end of the jig for further treatment on tables. The dewatering screen had 1.5-mm. openings; the screening efficiency was as follows:

Screen product, size of opening	Screen feed %	Screen over- size, %
Over 1.5 mm.	80.1	87.5
Through 1.5 mm.	19.9	12.5

Weight of undersize in the oversize = $80.1 \times 12.5 \div 87.5 = 11.44$. Screening efficiency = $19.9 - 11.44$ or $8.46 \div 19.9 = 42.51\%$.

Another important point is that the greater the quantity of slime in the feed the more value or fine mineral particles will be forced over the jig by the flow of the top water. This fact is especially true as the quantity of water added to the cells of the jig increases the top water of each succeeding cell. Better work can also be obtained from the jig by having clear top water, which is another reason, when the material is not sized, why the feed to the rougher-jig should be de-slimed, although this would not mean the elimination of the dewatering screen at the end of the rougher-jig.

Copper Production for Six Months

The following compilation shows properties in North and South America whose production for the first half of 1916 has been reported, in pounds:

	1916	1915	Increase %
Anaconda	164,500,000	112,200,000	46
Phelps, Dodge & Co.	85,000,000	65,000,000	30
Utah Copper	84,949,000	67,216,000	26
Calumet & Hecla and subsidiaries	79,882,000	60,000,000	33
Kennecott	61,400,000	445,000,000	36
Inspiration	53,847,000	*	..
Nevada Con.	43,346,000	26,020,000	66
Cerro de Pasco	36,000,000	26,000,000	38
Ray Con.	35,580,000	28,987,000	22
Calumet & Arizona	34,875,000	129,000,000	20
Chino	34,365,000	30,185,000	13
Copper Range	26,000,000	24,000,000	8.4
Miami	25,585,000	17,574,000	45
Greene-Canaanea	25,212,000	*	..
Braden	23,200,000	15,238,000	52
Granby	22,059,000	17,140,000	28
Chile	19,724,000	*	..
Old Dominion	19,759,000	11,372,000	73
Quincy	11,000,000	10,000,000	4
Mohawk and Wolver- ine	9,571,000	11,595,000	115
Total	895,854,000	596,527,000	50

*No production. †Estimated. ‡Decrease.

In the first half of 1915 the Greene-Canaanea plants were closed owing to disturbances in Mexico. The Chile Copper Co. did not start its mill until May, 1915, so that the copper produced to end of the following June was only a few thousand pounds. The Inspiration mill did not get under way until June 2, 1915.—*Boston News Bureau.*

More than half the world's production of copper in normal times is used for the manufacture of electrical equipment.

Cyaniding Clayey Ore at the Buckhorn Mine, Nevada

By Paul R. Cook

*The ore deposit of the Buckhorn Mines Co., Buckhorn, Nevada, is peculiar as it occurs as a shallow kaolinized mass of material with basalt walls, having apparently no direct connection with any of the usual gold-bearing rocks. The ore generally contains 16% water of hydration, and the cyaniding of this hydrous clayey material offered unusual difficulties when compared with the typical gold-quartz ores of Nevada. The orebody was thoroughly developed. Then the mill was built according to the latest cyanide practice, embodying changes necessitated by the peculiar nature of this ore; but on starting the mill, the ore proved more difficult to treat than had been anticipated.

Considerable trouble was experienced in mining the sticky ore and getting it to the treatment plant. The next problem was to get the ore out of the mill-bin and to crush it. The bin was an ordinary circular steel type, with natural earth bottom and side gate. This ore would not run from the bin. The mill was designed to treat 300 tons per day, but even with one man in the ore-bin and two at the crusher, it was impossible to get more than 150 tons through in 24 hours. In crushing, the large kaolin lumps gave the most trouble.

The jaw-crusher was discarded in favor of high-speed toothed rolls that gave the desired crushing capacity. The rolls are well adapted for sticky ores. To dispense with a man on each shift shoveling ore out of the bin, a 36-in. conveyor-belt was installed to feed the crusher. The opening in the bottom of the bin over the belt was 2 ft. wide, extending clear across the bin. It was closed by means of short pieces of mine rails that could be removed as desired to allow the ore to be drawn out.

The 45 by 15-in. Anaconda-type rolls with smooth shells would clear themselves fairly well if one of the shells had a channel 1 in. wide by $\frac{1}{2}$ in. deep machined in it, but it was troublesome to keep a groove in the shells as they wore down.

One 6-ft. Hardinge ball-mill was intended to reduce the whole tonnage. After plastering the balls to the side of the mill with clay a few times, the mill-men learned by the sound of the mill when it was beginning to choke; feed was then cut off.

Another ball-mill made it possible to keep the rest of the plant going while grinding out the mills, one at a time, and allowed the rolls being set coarser on sticky ore. With clean ore 300 tons per day was sometimes put through one mill.

The ball-mill discharge was classified in two 36-in. Akins classifiers, the oversize fed to two 5 by 18-ft. tube-mills with Komata liners. The tube-mill discharge was classified in a home-made drag-classifier. The small

quantity of material requiring re-grinding included fragments of basalt 'nigger-heads.' This material was almost as hard as the pebbles themselves and of low assay-value. Occasionally enough accumulated in the circuit to be troublesome and was thrown out. A small amount was thought to help grinding. About 80% of the product delivered to the cyanide plant would pass a 150-mesh screen.

Of the mill-head value 80% was dissolved in the crushing-plant. Only small additional extraction could be obtained in the rest of the plant. The real trouble was to remove the dissolved value from the clayey pulp. Accordingly the three 32 by 14-ft. Dorr agitators were changed to thickeners. These settled 300 tons daily of 1 to 10 pulp, as delivered from the crushing-plant, to a specific gravity of 1.15. The 8 sq. ft. of settling area provided per ton of this ore settled in 24 hr. would be sufficient to settle an average Nevada quartz ore to a specific gravity of 1.33. The overflow was precipitated, and the underflow mixed with the barren solution and fed to six 36 by 12-ft. Dorr thickeners, delivering a 1.23 specific gravity underflow to the filters. The 20 sq. ft. of settling area per ton settled in 24 hr. is three times the area required to settle an average Nevada ore to a specific gravity of 1.33. Primary thickeners were held with 2 ft. of clear solution; the secondary thickeners with 6 in. It was impossible to settle the raw Buckhorn ore beyond a specific gravity of 1.26, either in the mill or experimentally.

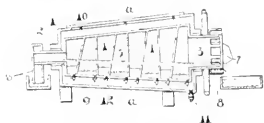
The maximum capacity of each of the four 14-ft. diam. by 12-ft. face Oliver filters was 50 tons per day, about one-half their capacity on average Nevada ore. An additional filter, 24-ft., had to be installed to filter 300 tons per day.

A sample of Buckhorn ore, dried carefully at a temperature below 110° C., had a specific gravity of 1.9. A higher temperature gave an additional loss of 16% in weight, and entirely changed the physical properties of the ore. The dehydrated sample had a specific gravity of 2.4, and settled and filtered almost as well as a quartz ore. Dehydrating also removed the sticky qualities. Both samples, however, gave the same extraction with cyanide. The temperature of a laboratory electric hot-plate was sufficient to dehydrate a sample nicely. As CO_2 , etc., would not be driven off at this temperature, this loss in weight must be due to water of hydration. With cheap fuel, dehydration before milling would be the best treatment for this class of material. The ore would mill and classify easier, the thickeners and filters would have normal capacity, and dissolved metals would be more completely removed. The temperature of a commercial drier would dehydrate the ore with about the same fuel consumption (100 lb. of coal per ton of ore) as in removing the 18% H_2O if it existed in the form of moisture. The high price of fuel delivered at Buckhorn prevented the adoption of dehydration at this mill. The ore was treated raw at the cost of \$1.59 per ton; total costs were \$2.55 per ton. Power cost \$8 per hp. month.

*Abstract from paper prepared for Arizona meeting of the American Institute of Mining Engineers.

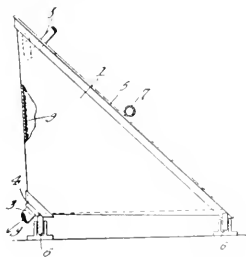
Recent Patents

1,190,012. AMALGAMATOR. Percy A. Robbins, Timmins, Ontario, Canada. Filed Oct. 10, 1914.



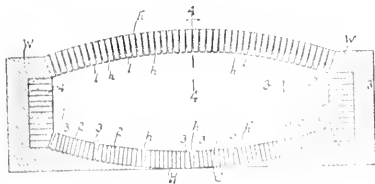
1. Amalgamating apparatus comprising a chamber journaled for rotation and provided with an axial opening and a circular axial outlet opening, the chordal planes of segments of the chamber tangentially intersecting the periphery of the outlet opening at different points of the circumference thereof varying in area to cause the surface of contained mercury to alternately approach and recede from the axis of rotation as the chamber is rotated.

1,190,306. ORE-CONCENTRATOR. Rudolph Leonhart, San Anselmo, Cal. Filed Oct. 6, 1914.



An ore concentrator including a conical body mounted for rotation and having a substantially perpendicular portion leading downwardly to the apex of the body and a slightly inclined portion leading upwardly to the apex of the body, there being an outlet at said apex, means for rotating the body in one direction about an axis extending along said slightly inclined bottom portion, means for directing values onto the bottom portion of the table between the outlet and the front of the table, and means extending along the periphery of the table at the uppermost portion thereof, for directing water downwardly toward the outlet to direct into the outlet values adhering to the table.

1,191,271. FURNACE CONSTRUCTION. James A. Bow and Peter Thill, Great Falls, Mont., and Archer E. Wheeler, London, England. Filed Dec. 17, 1914. Serial No. 877,706.



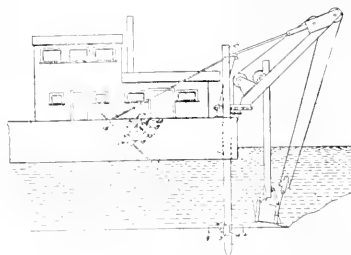
1. In a furnace of the character described, a roof provided with longitudinally disposed expansion joints opening into the treatment chamber, and transverse joints likewise opening into said chamber, the several joints being closed to the atmosphere.

2. In a furnace of the character described, a roof composed of bricks bonded and laid in courses and forming longitudinal

and transverse expansion joints opening into the treatment chamber, and means for closing said joints to the atmosphere.

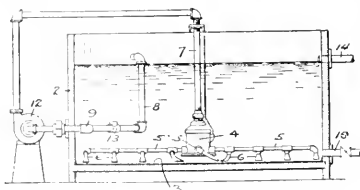
3. In an arch or roof of a furnace of the character described, a pair of bricks positioned to form a joint opening into the treatment chamber but closed to the atmosphere, and means on the bricks outside the roof for preventing the bricks from dropping into the treatment chamber.

1,188,899. DREDGE-SPUD BRACE. Albert Basil Clardy, Balboa, Canal Zone. Filed July 31, 1915. Serial No. 42,975.



1. The combination with a dipper dredge and a spud connected therewith, of means connected adjacent the lower end of the spud and extending thence upwardly and rearwardly to brace the same, and means temporarily holding the upper end of said bracing means, substantially as set forth.

1,192,478. AMALGAMATOR. Albert E. Vandercook, Alameda, Cal., assignor to California Macvan Company, a Corporation of California. Filed June 16, 1914. Serial No. 845,387.



1. In an amalgamator, a tank, a mercury covered plate arranged in said tank, a hollow armed rotatable structure arranged above said plate, nozzles on said structure directed toward said plate, a pump arranged externally of said tank and arranged to force liquid through said structure and nozzles, a suction pipe for said pump opening into the tank below the normal level of the liquid therein and a feed pipe extending into said tank and terminating below the normal level of the liquid therein and in close relation to the end of the suction pipe, whereby material discharging from the feed pipe is drawn directly into the suction pipe.

1,190,549. PROCESS OF RECOVERING VALUES FROM ORES. Henry Hirsching, Oakland, Cal. Filed November 28, 1913.

A process for recovering copper, silver and gold from roasted or unroasted ores, consisting in acting on the ore with aqueous ammonia, thereby dissolving the copper and the silver, expelling the ammonia from the solution, thereby causing a precipitate from the solution of the black copper oxid and silver oxid, settling and decanting, dissolving the precipitate with sulfuric acid, electrolyzing to deposit copper, recovering the silver, and recovering the gold from the ore residue substantially as and for the purpose set forth.

Mineral Production of California in 1915

The mineral output of California during 1915 was valued at \$96,663,369, for crude materials, including 49 different minerals. Of the 58 counties in the State all but two contributed some mineral product. Compared with the 1914 output, the two notable features are the almost startling increases in some of the metals, and the decrease in petroleum, both in quantity and total value. The result, however, is a net increase in the grand total value of \$3,348,596 over the 1914 total. Of the metals antimony again entered the active list after an absence of several years. Copper increased over 10,000,000 lb. in quantity and \$3,114,192 in value; gold increased \$1,788,800; quicksilver increased 25% in quantity and more than doubled in value; tungsten jumped from a value of \$180,575 to \$1,005,467; zinc gained from 339,641 lb., worth \$20,381, to 13,043,411 lb.

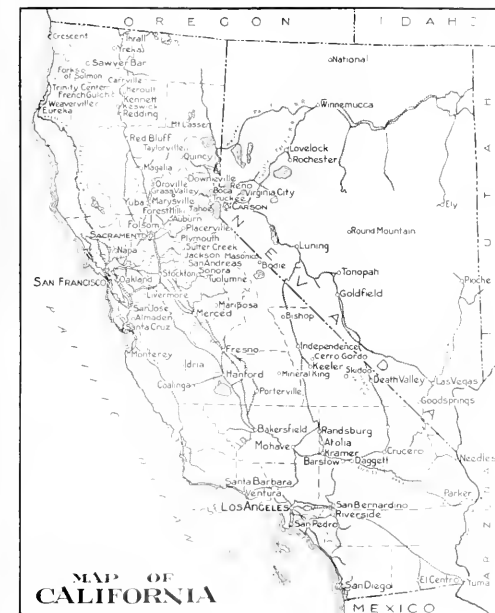
ceived by the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

Mineral	Quantity	Value
Antimony ore, tons.....	510	\$35,666
Asbestos, tons.....	143	2,860
Barytes, tons.....	410	620
Bituminous rock, tons.....	17,789	61,468
Borax, tons.....	67,004	1,664,521
Brick.....	180,538,000	1,678,756
Cement, barrels.....	4,918,275	6,041,950
Chromite, tons.....	3,725	38,044
Clay (pottery), tons.....	157,866	133,724
Coal, tons.....	10,299	26,662
Copper, pounds.....	40,968,966	7,169,567
Dolomite, tons.....	4,192	14,504
Feldspar, tons.....	1,800	9,000
Fuller's earth, tons.....	692	4,002
Gems.....	.....	3,565
*Gold.....	.....	22,412,296
Gypsum, tons.....	20,200	48,953
Infusorial earth, tons.....	12,400	62,000
Iron ore, tons.....	724	2,584
Lead, pounds.....	4,796,299	225,426
Lime, barrels.....	356,534	286,204
Limestone, tons.....	146,324	156,288
Lithia, tons.....	91	1,265
Magnesite, tons.....	39,721	283,461
Manganese ore, tons.....	4,013	49,098
Marble, cubic feet.....	22,186	41,518
Mineral paint, tons.....	311	1,756
Mineral water, gallons.....	2,274,267	467,738
Natural gas, cubic feet.....	21,982,892,000	1,706,480
Petroleum, barrels.....	91,146,620	43,502,837
*Platinum, ounces.....	667	21,149
Potash, tons.....	1,076	19,391
Pumice, tons.....	380	6,400
Pyrite, tons.....	92,462	293,148
Quicksilver, flasks.....	14,199	1,157,449
Salt, tons.....	169,028	368,737
Sandstone, cubic feet.....	63,350	8,438
Silica (sand and quartz), tons.....	28,904	34,322
*Silver.....	.....	851,129
Slate, squares.....	1,000	5,000
Soapstone and talc, tons.....	1,663	14,750
Soda, tons.....	5,799	83,485
*Stone, miscellaneous.....	.....	5,011,108
Tungsten concentrates, tons.....	962	1,005,467
Zinc, pounds.....	13,043,411	1,617,383

\$96,663,369

*Courtesy of U. S. Geological Survey.

†Includes granite, macadam, rubble, paving blocks, sand and gravel, and grinding-mill pebbles.



valued at \$1,617,383. Petroleum decreased approximately 12,000,000 bbl. but the average price per barrel was slightly higher, so that the net result was a decrease in value of \$3,983,272.

California yields commercially a greater number and variety of mineral products than any other State in the Union, and possesses latent possibilities in other items so far undeveloped. The total annual value of the output is surpassed by only four other States, they being the great coal and iron producers east of the Mississippi river. California is the sole producer of borax, chrome, and magnesite. For several years the State has been leading all others in gold, petroleum, platinum, and tungsten; but was surpassed in 1915, for the first time, in petroleum by Oklahoma.

During 1916 there is certain to be a considerable increase in the output of chrome, copper, magnesite, tungsten, and zinc. Many new deposits of chrome and magnesite are being mined. Inyo county will swell the tungsten yield.

The following table shows the yield of mineral substances in California during 1915, as compiled from the returns re-

At the coming convention of the American Electrochemical Society to be held at New York on September 27 and 30 one of the sessions will be devoted to 'Made in America' products of the electric furnace and electric cell. These products include many of the most important staples such as copper, aluminum, abrasives, and bleach. While such chemical industries as coal-tar dyes are distinctly European, the electrochemical industry is decidedly American. Aluminum was invented here and put on a commercial basis. The first plant for the electrical synthesis of the elements of the air and the production of artificial fertilizer nitrate was erected at Niagara Falls. Large quantities of abrasives are made in the electric furnace. Other electrochemical products of importance are graphite, phosphorus, hypo-chlorite of lime, magnesium metal, carbon bisulphide, calcium carbide, hydrate of sodium, ferro-silicon, and other iron alloys.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

PROSPECT MOUNTAIN.—RE-OPENING THE GREENBACK.—WOLFTONE SHAFT.—ROBINSON DISTRICT.—HARVARD AND PENROSE SHAFTS.

The first extensive development to be undertaken in the new Prospect Mountain territory since ore was discovered in the Valley adit has been started by Clarence Jarbeau, manager of the Julia Mining Co., now operating the Home Extension and Cloud City properties in the Down Town section. Mr. Jarbeau has organized a strong company, and secured a long term lease on the old Mansfield claims on the north-west slope of Prospect mountain. The property is owned by the Lanphier brothers, operators of the Penn mines on Breece hill. They have done some development on the Mansfield in past years, the most recent work uncovering a large body of iron-manganese ore. A low price was offered for the ore at the time, and it was not profitable to continue work. The ground has been unworked for a number of years. Mr. Jarbeau thinks that the Mansfield, as well as the many other properties on Prospect mountain, will prove as rich in ore as the territory throughout Breece, Fryer, and Carbonate hills, and he has determined on thorough development. The Lanphier adit was driven a distance of 200 ft. This is to be continued 250 ft. farther, when cross-cutting from the main opening will be started at several points. The exposure of iron-manganese ore will be explored at once, and it is thought that shipments of it will be made soon, as there is a good market for it. The Mansfield includes 12 full claims located midway between the holdings of the Valley and that of the Anderson tunnel near Birdseye.

Patrick Mulrooney, owner of the Greenback mine in Graham park, has undertaken another important step in its re-opening. Recently the shaft was re-timbered at the 900-ft. level. The pumping that was carried on through the Wolftone shaft drained the Greenback to this point, where there is a large steam pumping plant that has been under water for several years. The pumps have been repaired and are in good order. It has been decided to drain the Greenback to the bottom level, 1350 ft. A Layne-Bowler deep-well electric pump of 1000 gal. capacity has been purchased for this, and is expected within a week. A 150-hp. motor has been installed on the 900-ft. level for propelling the sinking pump. The water will be raised by the sinker to the 900-ft. level, where it will discharge into the old steam plant, which in turn will deliver to the surface. It is thought that the dow will not exceed 500 gal. after the shaft has been drained. The Colorado Power Co. has completed the erection of a line to the Greenback, and linemen are now erecting a transformer-house at the property. Transformers have been delivered for installation, and everything will be in readiness for operation as soon as the pump is installed.

The Western Mining Co. is preparing to continue the draining of the Wolftone and surrounding mines to a depth of 1950 ft., the bottom of the Wolftone shaft. The pumping that has been done in this shaft has already reduced the water-level in the Greenback, Mikado, and Pyrenees 150 ft., and has completely drained the Robert Emmet. With further draining prepared for the Greenback and the Mikado, this section of the district will soon be open for deep mining.

The old Robinson Kokomo district, just over the line in Summit county, is in the midst of the greatest boom that has

been known for some years. A year ago there was nothing doing throughout the entire district. Two or three old properties were active, but they were producing only a small tonnage, employing a few men. Now there are 14 mines working, all of them shipping heavily and employing a total of 250 men. The bulk of the ore being extracted is a lead-zinc sulphide, which is shipped to the Progress mill near Robinson. This plant, formerly known as the Wilson mill, has been completely overhauled and re-modelled by the Progress people, and at present is one of the most efficient separation plants for lead-zinc ores. It is a combination process of flotation that gives unusual results. The mill has a capacity of 500 tons and is working regularly.

A rich gold, silver, and lead strike has just been made on the Columbine property near Robinson, which is under lease to some Leadville mining men. A 3-ft. vein assaying 4 oz. gold, 786 oz. silver, and 10% lead has been opened. Several shipments have been made. Estimates on the returns from the ore now at the smelter give \$15,000 a 25-ton carload, an average value of \$600 per ton. The Columbine is one of the oldest mines in the Robinson district, and has just been re-opened by lessees after years of inactivity. It has produced lead and silver heavily, and was known to contain rich lead-zinc veins. The present operators proposed to develop the zinc deposits, and were proceeding with this work when they discovered the silver ore. One of the men was digging a drain at the bottom of a 70-ft. slope when he found the ore. Other prospecting exposed the vein for 11 ft. A large tonnage is being extracted, and the mine has every indication of becoming one of the richest producers of the district.

The water problem at the Harvard property on Fryer hill, being exploited by the U. S. S., R. & E. Co. has finally been solved. The flume that was constructed through part of Evans gulch, which is now carrying the stream past the Harvard, has effectively blocked the surface water that was causing considerable trouble. Immediately after the water had been turned into the flume, the flow in the shaft decreased from 300 to 500 gal. per minute. The mine is now being rapidly drained. Preparations are being made for sinking the shaft another 300 ft., making it 1040 ft. deep.

Drainage of the Penrose shaft and workings in the Down Town basin is now complete. The large 4-stage electric centrifugal station-pump of 2000-gal. capacity has been installed at the bottom level, and connected with its 650-hp. motor. A water-column has been attached, and the pump is now steadily throwing a large stream to surface against a head of 870 ft. One of the sinkers has been removed from the shaft, this compartment being used for hoisting. The flow, which is estimated to be between 2500 and 2800 gal. per minute, will be handled by the station-pump at the bottom, and one sinker working in relay with the relief pumps at the 450-ft. level. Mining in the old workings is extending. Surface rights to a large area surrounding the Penrose have been purchased for dumping. Most of this ground has been occupied by residences; the buildings are being moved to other locations. It is officially reported that ore has been exposed in several places and that shipping will be started in a short time.

Returns from the Pittsburg mine in lower Russell gulch, Gilpin county, continue rich. Two recent lots yielded 6.61 oz. gold, 7 to 8 oz. silver, and 6.5 to 16.5% copper. This was mined from a depth of 900 feet.

VICTORIA, BRITISH COLUMBIA

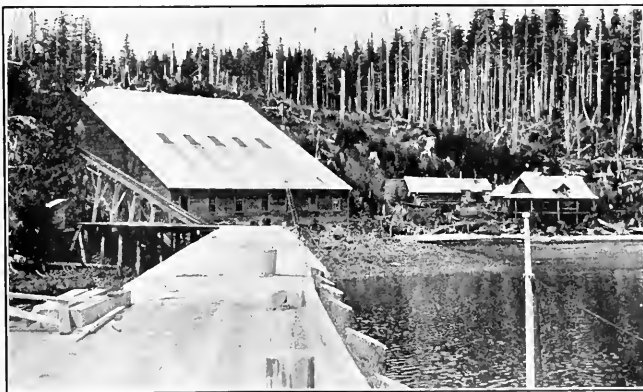
SIX MONTHS' PROGRESS IN MINING AND METALLURGY.

Generally, the mining industry of this Province made progress during the first half of 1916. The chief trouble recorded was in the latter half of June, there being delay in delivery of ore from the silver-lead-zinc mines shipping to the Consolidated Mining & Smelting Co.'s works at Trail, rapidly melting snow having caused floods that damaged railways and wagon-roads and, in several instances, washouts that broke water-supply lines to mines and concentrating mills and in other ways interfered with mining and milling operations over a period of two to four weeks. The second half of the year opened with labor disputes in the Crownsnest coal-mining region, the colliery employees having demanded a higher "war bonus" than the operators were willing to concede, consequently there was a stoppage of work for a short time and a resultant break in coal and coke production. The shortened supply of the latter made necessary a curtailment of operations at copper-smelting works. However, a settlement is in sight.

As indicating the progress made in Kootenay district this year, the figures showing the ore receipts at the Trail smelter are, on the whole, satisfactory. In making the following comparison of the totals of ore-receipts in the first half of each of three years, 1914, 1915, and 1916, it should be kept in mind that the outbreak of War in Europe did not affect figures for the 1914 period quoted, since War was not declared until after the close of that half-year. It did affect the 1915 period, however, and so far as a few mines previously producing regularly but not operated since the outbreak of War, to some extent the 1916 period also. The several half-yearly totals were as follows: to June 30, 1914, 183,427 tons; June 30, 1915, 217,627 tons; and June 30, 1916, 245,466 tons. The increase in receipts was largely from mines operated by the Consolidated company itself, custom ores having increased only from 38,131 tons in the 1914 half-year to 40,265 in the corresponding period of 1916, the latter having been a substantial improvement on the 1915 figures, which were 21,511 tons to June 30 of that year. The total quantity of custom ores received from British Columbia mines during the first half of 1914 was 29,464 tons, compared with 6386 tons in the corresponding months of 1915, and 25,258 tons in that of 1916. On the other hand, receipts from mines in the United States, chiefly in the northern part of Washington, were 8667 tons in the 1914 period, 15,125 tons in that of 1915, and 15,997 tons in that of 1916. In this connection it may be mentioned that ores from the State of Washington have also been sent to smelting works in the Boundary district of British Columbia, though these and Trail will hereafter have a strong competitor in the lately remodeled reduction works at Northport, Washington. Another thing to be taken into account is that the larger mines in Slocan district have this year taken advantage of the high prices for zinc, as is seen by the following comparison: zinc ore and concentrates shipped during the first half of 1916 included 5476 tons for the Standard, 2220 tons from the Lucky Jim, 1647 tons from the Galena Farm, and 1110 tons from the Slocan Star, a total of 10,453 tons, compared with only 83 tons from all four mines in 1915. The figures for the Surprise mine are the other way; its 1915 total, to June 30 was 3058 tons of zinc product, while that for this year is only 185 tons, the destruction of the concentrating mill by fire having prevented production this year pending completion of a new mill.

The foregoing figures do not include ore production in Boundary and Coast districts, in which are situated the larger copper mines of the province. Full particulars are not available just now, but an idea of progress may be obtained from the following figures showing the amount of copper produced by the Granby company, practically all from its own mines in the two districts mentioned. In January, 3,122,879 lb.; February, 2,690,265 lb.; March, 3,555,411 lb.; April, 3,950,469 lb.; May, 4,727,929 lb. The Britannia company made an increase.

Summarizing the position so far as concerns some of the larger producing mines in Kootenay district, it is noteworthy that East Kootenay mines sent to Trail in six months of 1916 37,094 tons of ore—nearly all from the Sullivan mine—compared with 10,766 to June 30, 1914; and West Kootenay mines 189,972 tons against 163,073 tons. In regard to West Kootenay, there was an increase from Rossland mines from 128,000 tons in the 1914 period to nearly 172,000 tons in that period of 1916; while on the other hand receipts at Trail from mines in Ainsworth, Slocan, and Nelson divisions decreased from 35,100 tons in the first part of 1914 to 16,700 tons in that of 1916. Yet on the whole, there is believed to have been an appreciably large



MILL AT THE SEA-LEVEL MINE NEAR KETCHIKAN, NORTH OF THE BRITISH COLUMBIA BOUNDARY.

increase in ore production for the province compared with 1914 and 1915.

Metallurgical progress has been keeping up with that of mining. The most striking changes are those made at the Consolidated company's works at Trail. Accompanying a picture of the new zinc-refining works at Trail used lately in New York newspapers was the statement that Trail is the only place in the world where gold, silver, lead, zinc, and copper are all refined. Whether this be so or not, the fact remains that operations at Trail now include the electrolytic refining of lead and zinc, and probably copper if the new plant has been completed, while the refining of gold and silver has been done there for years. There is little if any change at Boundary district copper-smelters, long noted for their efficiency; a higher gold-saving standard has been reached at the Hedley Gold Mining Co.'s 40-stamp mill and cyanide plant; in Slocan district, several of the older wet-concentration mills have been much improved and two or three new ones erected and equipped, flotation being provided for in several instances; it is claimed that the French zinc-saving process will soon be in successful operation at Nelson; the Britannia company has made striking progress with its enlarged mill, using the M. S. flotation process on silicious copper ore; and the Granby's smelter at Anyox is producing copper at low cost, with complete satisfaction to the management.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the best press.

ALASKA

FAIRBANKS. From the Eldorado mine at the head of Cleary creek, 16 tons of lead ore was shipped to smelters last month. This is the first time that galena has been sent from the Tanana valley.

LIVENGOOD. A preliminary report on the Tolovana district, by Alfred H. Brooks, has been published as Bulletin 642-G of

limestone, and black and red slates, with some chert beds. The gold-bearing gravels are largely greenstone and chert, as well as quartz. The deposits are in four classes, namely, deep, bench, and creek gravels, and slide material. The deep channel gold of Livengood creek is dark colored, and is worth from \$18.75 to \$18.90 per oz. This channel constitutes the most continuous placer deposit that has been developed here, what seem to be parts of the same channel having been

opened at several places for 3 to 4 miles. The richest gravels developed are in this channel and in the streams cutting across it. The town of Livengood is the commercial centre of the district. There is abundant timber available, but hardly enough water for sluicing.

ARIZONA

GLOBE. During the first half of 1916 the Arizona Commercial produced 2,251,000 lb. of copper and a net profit of \$334,000. Development on No. 14 level is opening more and better ore than above. Machinery for the power-plant is being delivered at the mine.

HUMBOLDT. The Consolidated Arizona Smelting Co. reports as follows for the second quarter of 1916:

Ore reserves on July 1, tons	
(increase of 200,000)...	500,000
Mill treated, tons.....	20,884
Smelter reduced, tons (including custom ore)....	26,077
Copper output, pounds....	2,450,000
Gold, ounces	1,576
Silver, ounces	35,788
Net profit	\$249,503

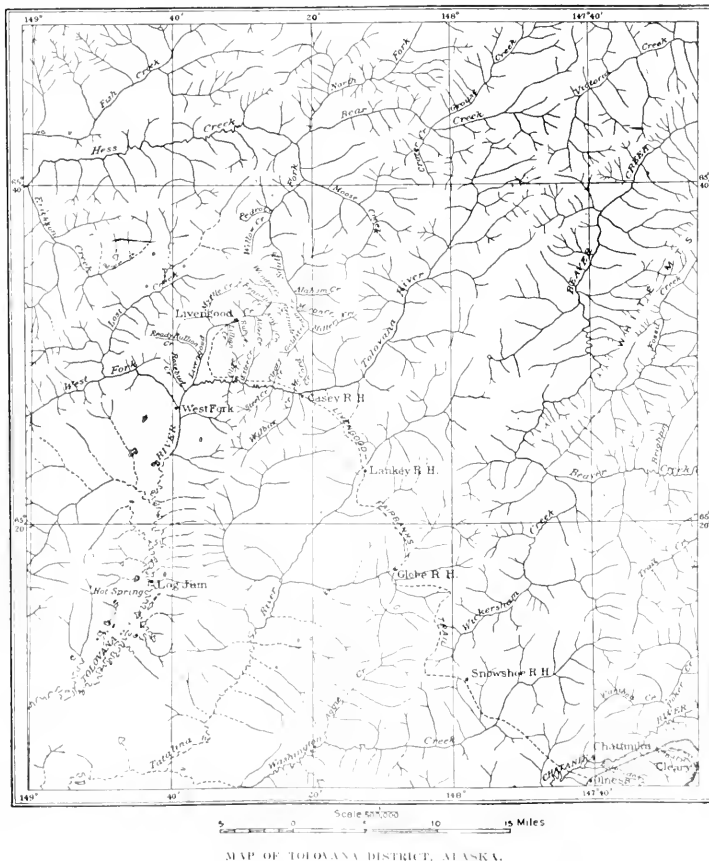
All figures are a considerable increase over those in the first quarter, the profit being \$88,546 greater. As mentioned in last week's issue, the crushing-plant, sample-mill, and ore-bins at the smelter were burned on June 9; but this is quickly being remedied.

NOGALES. In its issue of August 15 *The Oasis* has a special mining edition describing conditions in Santa Cruz county. A map shows the position of the mines.

OATMAN. At a vertical depth of 110 ft. in the Lexington mine a lode 9 ft. wide, of good value, has been cut. Of this 30 in. assays \$12.50 per ton. This strike is the best found so shallow in this district.

At the Boundary Cone the lode is 26 ft. wide.

PATAGONIA. To develop a gold-silver-lead-zinc property 27 miles north-east of Nogales and 25 miles south of Patagonia, the Santa Cruz-Bisbee Mining Co. has been formed in the Warren district. J. F. Walker is in charge.



the U. S. Geological Survey. The region lies in the headwater territory of Tolovana river, which flows southward into the Tanana, and in the upper basin of Hess creek, which flows westward into the Yukon. Gold placers have been found and are being developed there. Production so far has been confined chiefly to the ground on Livengood creek. The present rush set in during 1914 and 1915. From 19 properties the output last year was \$80,000. The topography of the country shows the characteristic flat-topped ridges of the Yukon-Tanana upland. The bedrock is mainly cherty crystalline

CALIFORNIA

The California Metal Producers Association and the California State Tax Commission met in joint session at the offices of the Association on August 19 for the purpose of discussing plans providing for a uniform system for mine assessment and taxation. Several proposals were discussed. Plans to be finally agreed on will be submitted to the Commission for its further consideration.

DEDRICK. At the Globe Consolidated work has been resumed in charge of H. M. Ball. Part of the 20-stamp cyanide mill is to be kept working. A lower adit is being driven to open the veins at depth.

GRASS VALLEY. At the Golden Gate mine \$5000 has been spent since June 29 in reconstruction of the mill, 800-ft. surface tram, and other work. The plant now has a capacity of 60 tons daily. It is said that the Pacific Western Commercial Co. is to treat tungsten ore brought from other districts.

The old placer town of You Bet was considerably burned last week.

HEROULT. At the Noble Electric Steel Co.'s smelter one furnace has been in continuous operation since April 14 making ferro-manganese and other products.

KENNETT. The Mammoth company is making good progress in driving the 5000 and 4000-ft. adits in its Mammoth and Friday-Lowden mines.

In the Bully Hill area of the copper belt a dozen properties are busy. The Green Horn is to install motors.

ORVILLE. On August 24 the Natoms company commenced re-dredging tailing on the Feather river. This ground was dredged in 1909. G. H. Thurman is in charge of this new work.

YREKA. The Eliza, one of the oldest gold mines in Siskiyou county, 12 miles from this place, has recently been examined by an engineer. Seven years ago the property was acquired by W. B. Shearer, R. H. De Witt, and A. E. Junker of Yreka, with O. H. Lawson in charge. A considerable amount of exploration was done since then, especially on No. 5 level, which is in 1700 ft., 1000 ft. of which contains \$5 per ton free gold, and is heavily mineralized. Ore reserves are estimated at 70,000 tons. A 30-ton mill-test yielded \$5 per ton free gold, the feed being \$7.69 per ton. Facilities for mining and working the 10-stamp mill are abundant. A lower adit is to be driven, also additional plant is proposed.

COLORADO

According to the deputy State mining commissioner, M. B. Tomblin, there are 15,000 men employed at Colorado mines, an increase of 50% over the number in the same period of 1915. There were 26 fatalities, a decrease of 40%.

ALMA. In the new tungsten field in Park county there is great activity. Several mines are opening well.

OURAY. The most active of the new properties commencing work is the Vernon near Ironton. At present the company is installing a new hoist and is building a bunk-house, boarding-house, and shaft-house. At 69 ft. depth there is from 10 to 12 ft. of high-grade enargite ore. A. G. De Golyer is manager.—The Revenue mine has 20 men cleaning-up and re-timbering, preparatory to starting on a large scale.—The Ouray Tungsten Mining Co. has leased part of the Wanakah mill below Ouray, and will concentrate its ore there until it builds its own mill at the property. G. W. Barnhart is manager.

PLACERVILLE. The Primos Chemical Co. has withdrawn its miners from the vanadium mines above Placerville, and arranged them between the property at a point a short distance below Sawpit and at the Bear Creek mines. There is plenty of ore developed and being extracted to keep the plant at Vanadium working at full capacity. Labor-saving devices are being put in. At the mine and mill there are 100 men.

KANSAS

PITTSBURG. At the Joplin Ore & Spelter Co.'s zinc smelter two blocks of retorts have been stopped indefinitely.

MICHIGAN

THE COPPER COUNTRY

The Calumet & Hecla company reports as follows for July, in pounds:

Mines	July	7 months
Almreek	1,741,097	13,292,292
Allouez	744,624	5,862,531
Calumet & Hecla	6,172,908	44,330,490
Centennial	190,262	1,459,959
Isle Royale	980,574	7,916,340
La Salle	93,580	726,188
Osceola	1,818,241	11,609,680
Superior	183,020	1,941,485
Tamarack	476,652	3,923,077
White Pine	277,941	2,468,413

MISSOURI

JOPLIN. Zinc ore advanced \$5 per ton last week, the top price being \$70 per ton for 60% content. The output of the region was 4063 tons of blende, 364 tons of calamine, and 822 tons of lead. The total value was \$309,142, and for 33 weeks \$22,898,046. A shortage of water is bothering mines and mills in the district, several of them being closed until rain or until supplies are obtained.

A 300-ton mill is to be erected by the Bell Mining Co. at Duenweg. A new shaft is down 105 ft., ore occurring at 140 ft. The ore contains up to 15% zinc.

MONTANA

BUTTE. Connection has been made at 2600 ft. in the Tuolumne, and mining is to commence on that level. The output can be increased 25 per cent.

Wages in August will be \$4.50 per shift on account of copper being over 25 cents per pound.

NEVADA

FAIRVIEW. In June the Nevada Hills company made a profit of \$8738, and \$19,155 in the first quarter. Quick assets amount to \$302,000.

HORN SILVER. At the Hardwick-Reid lease on the Orlean property, from 12 to 36 in. of \$80 ore has been opened, also a foot-wall seam of several inches assaying 5 oz. gold and 1700 oz. silver per ton.—At the Horn Silver company's mine a 40-hp. hoist has been installed. The shaft is 510 ft. deep. Plenty of milling ore is opened.

(Special Correspondence.)—The Pocahontas mine has been bonded for \$50,000 from M. Feeney by F. W. Cole and D. W. Minier, president and general manager respectively of the Azalia Mining Co., operating the Azalia and Surprise properties in this district. The Pocahontas is between the Yellow Pine and Red Cloud mines, and has been opened by a 300-ft. adit and 25-ft. shaft. The latter is to be deepened and equipment installed.

The Bullion Mining Co., composed of Salt Lake people, has taken over the Bullion mine and is preparing for a large output. The Bullion has been extensively developed and a considerable tonnage of shipping ore is said to be ready for extraction.

Shipments of gold-platinum ore are being made at the rate of \$12,000 per month from the Boss mine. The company is said to have devised a process for treating its ores, and will probably erect a plant in the near future.

Five concentrating plants are being operated in the district, and two more have been practically decided on. In addition to the ore treated by concentration, heavy shipments

of silver-lead and zinc ores are being made to custom smelters from a number of properties. Several important deals have been made recently, and the district is recording greater activity than ever. While the Yellow Pine continues to be the principal producer, the Anchor, Green Monster, Surprise, and several others are yielding well. On August 10 the Yellow Pine paid an extra dividend of 10c. per share. This makes \$750,000 for the current year, or 75c. per share. The company has \$84,000 cash. In June the output was 200 tons of lead and 1500 tons of zinc concentrate, giving a net profit of \$51,430.

Goodsprings, August 19.

JARRIDGE. There are 290 men employed at this place, where some encouraging strikes have been made recently.

TONOPAH. Some July returns were as follows:

Mine	Tons	Oz. bullion	Profit
Belmont	11,828	237,459	\$107,000
Extension	8,139	180,240	69,209
Jim Butler	4,752	.....	25,829
Tonopah	8,019	111,565	26,763

Last week the West End mill treated 828 tons of its own and 455 tons of custom ore. As to the status of the Jim Butler-West End litigation the Supreme Court of Nevada has granted a motion made by the Jim Butler attorneys to keep the proceeds of the ore extracted from the disputed territory impounded until the further adjudication of the case by the Supreme Court of the United States. In consequence, the returns from this ore will be tied-up for some time.

The district's output last week was 8916 tons worth \$186,568.

VIRGINIA CITY. Two new sinking pumps, motor-turbine type of combined capacity of 1000 gal. per minute, have arrived at the C. & C. shaft of the Pumping Association. The pumps are to be installed at 2900 ft. in the Ophir-Mexican winze to drain that level.

NEW MEXICO

ALBUQUERQUE. A year or more ago interest was renewed in the Carocito copper district, near Scholle, a station on the A. T. & S. F. railway, 50 miles south-east of Albuquerque. The ore is of the 'wood-copper' type, in sedimentary formations. Unlike most such bedded deposits of copper in the Western red beds, however, it lies mainly in limy-shales. Several horizons appear within a stratigraphic thickness of 100 ft. or less, but none is more than 2 ft. thick—usually not more than 10 inches. The field has been prospected over an area of some 10 sq. miles, according to the State geologist, Charles T. Kirk, though only one vertical shaft has been sunk below 25 ft. The Pritchard-Cavin mine is down 72 ft., 61 ft. of which is in ore containing from 7 to 9.5% by carload lots. Near the surface this ore is dominantly malachite, but soon passes into azurite, of better grade, and is now largely chalcocite at the shaft bottom. This ore is shipped without picking or other concentration to El Paso. Nearly all other properties are hand-cobbling ore from near surface workings, mainly open-cuts.

LOMBARD. It is probable that the Eighty-Five Mining Co. near here will erect a flotation plant in the near future. Tests have been made for some time.

(Special Correspondence.)—The Socorro Mining & Milling Co. shipped 1700 lb. of gold and silver bullion to Mint and several tons of concentrate to smelter, clean-up from the last half of July.

With good milling ore in the Eberle, and two different parts on the Clifton mine yielding profitable ore, the Oaks company is steadily proving the value of the 'Queen Vein' or 'Mother Lode' of the district, in which the management has always had great faith.

The new 3-compartment 6 by 16 ft. shaft of Mogollon Mines Co. has reached a depth of 820 ft. This company has started work on a board flume to keep tailing out of creek, the intention being to extend it to the present tailing storage-dam on Mineral creek, some 1 mile below and permanently keep

residue out of streams. The different companies have spent several thousand dollars in recent years, and now have the tailing problem well under control.

The companies of Mogollon have completed survey of the proposed new road to the Arizona line to connect with the route to Clifton; early action in this matter is expected.

Work on the Good Luck claims was recently resumed by the owners, Lauderbaugh and Thorlston. A 250-ft. cross-cut adit encountered the contact at depth of 170 ft., and it is understood the showing is satisfactory.

During first half of August the Mogollon Mines Co. treated 2013 tons of ore, producing 1600 lb. of gold-silver bullion and several tons of concentrate. The first section of tailing flume has been completed and is now in commission.

Flotation experiments made at one of the local mills show that the ores from the northern end of the district will give a high extraction. Whether or not other mines here will be aided by this method has not been fully determined. Careful tests are being made under various conditions with the hope of improving on and doing away with the cyanide process.

Mogollon, August 22.

TEXAS

(Special Correspondence.)—It is announced that the work of exploring this section for potash by the U. S. Geological Survey is soon to be resumed. The Government commenced boring for potash near Cliffside more than a year ago. It is considered that this part of the panhandle of Texas contains potash in commercial quantities.

Cliffside, August 25.

UTAH

ALTA. Progress in diamond-drilling by the Emma Copper Co. is between 45 and 50 ft. daily. The first hole, at an angle of 62°, is down below 500 ft. J. J. Beeson is the geologist in charge.

MORGAN. The Western Oil & Shale Co. is being organized by Chicago, Salt Lake City, and other people to operate extensive holdings of oil and shale land in Sanpete county. The shale is said to contain from 10 to 16% of paraffin. G. T. Stenhouse of Morgan is the leading spirit. About \$40,000 is to be spent.

SALT LAKE CITY. On account of Utah smelters putting an embargo on ore-supplies there is probably to be an investigation into the erection of another smelter nearby.

TINTIC. Shipments from 24 concerns last week amounted to 5400 tons. The Tintic Milling Co. sent out precipitate worth \$24,000. The plant is treating 100 tons daily, to be increased to 300 tons when the new roasting-furnaces are erected.

WASHINGTON

The Concomully and Ruby mining districts are in the north-central part of Washington, about 40 miles south of the Canadian border. The ore deposits were discovered in 1886, but production has been small owing to lack of transportation facilities, difficulty in treating complex ores, and the decline in the price of silver. The most valuable ore deposits in these districts consist of quartz veins which occur in schists near the areas of granite or at the contact of schist and granite. The ore minerals, pyrite, zinc-blende, chalcocite, and gray copper, carry silver and a little gold. A report on these districts, by Edward L. Jones, Jr., just published by the U. S. Geological Survey as Bulletin 640-B, contains a study of the geology and mineralogy of the region and detailed descriptions of the individual mines and prospects.

NORTHPORT. A statement issued by the Electric Point Mining Co. shows that the mine was discovered in June, 1915, and started producing lead ore in July, 1916. The company has 1,000,000 shares, 100,000 being in the treasury, 600,000 going to the incorporators. Cash on July 31 was \$13,537. From July 31 to August 11 shipments to Trail amounted to 533 tons, the present output being 75 tons daily.

CANADA

BRITISH COLUMBIA

GRAND FORKS. The Seattle and Loyal Canadian properties, 8 miles north of here, of which little has been heard for years, have been bonded by R. Clarke and others to E. E. Martin of San Francisco and associates for \$125,000. On the daily shipment of 50 tons of ore to the Granby smelter there will be paid a royalty of 50 cents per ton. J. McKay is in charge.

ONTARIO

COBALT. On September 15 the Kerr Lake will distribute 25c. per share, equal to \$150,000. This makes \$450,000 for 1916, and \$6,570,000 to date.

The Temiskaming shaft is down 1250 ft., nearly to the diabase-keewatin contact.—At the Beaver Con. exploration continues below 1600 feet.

PORCUPINE. The McIntyre mill is to be enlarged to 600 tons per day. The present capacity is 12,000 tons per month.

During the 28 days ended July 14 the Hollinger Consolidated made a profit of \$215,165 from 46,018 tons of ore. This averaged \$9.15 per ton. Costs totaled \$3.99 per ton.

Open-cut work is supplying two-thirds of the Dome ore. The new central shaft is causing some delay. A great quantity of ore is being broken on No. 4 and 5 levels. On No. 7 the orebody is 240 ft. wide.

Diamond-drilling at the West Dome is reported to be encouraging.

An orebody 40 ft. wide and 90 ft. deep has been opened by drilling at the Dome Extension.

KOREA

The July clean-up of the Oriental Consolidated was valued at \$128,750.

PHILIPPINE ISLANDS

Following is the statement of production of the Benguet Consolidated Mining Co. for the first half of 1916: The mill treated 8030 tons of ore, containing \$161,615, or practically \$20 per ton. The actual bullion recovered and shipped to mint was \$140,487 by mine assays, or an average of \$17.50 per ton. The total amount of bullion shipped was 10,539 oz., or equal to an average value of practically \$13.50 per ton.

The AMERICAN CHEMICAL SOCIETY will hold a meeting at New York on September 25 to 30, in conjunction with the Second National Exposition of Chemical Industries. Charles H. Herty, of the University of North Carolina, president of the Society, will open the Exposition on the 25th. His address will review the history of chemistry and the chemical industries of this country and outline developments since the outbreak of war in Europe. The presidents of co-operating societies, such as the American Electrochemical Society, American Institute of Mining Engineers, and American Paper and Pulp Association, will follow Dr. Herty with speeches of welcome and reviewing the progress made in the industries represented by them.

The UNIVERSITY OF CALIFORNIA Bulletin for July, of 269 pages, covers the announcement of courses for the academic year 1916-17 in the colleges of mining, chemistry, civil engineering, and others.

Instead of holding its 21st annual meeting on the Menominee Range, the LARI SUPERIOR MINING INSTITUTE will make a trip to the Birmingham district of Alabama on March 13, 1917.

The U. S. CIVIL SERVICE COMMISSION states that in the open competitive examination for junior mining engineer, to be held on October 11 and 12 on the subject of 'mining operations,' there will be two series of questions, one on coal and the other on metal mining. Competitors may be examined in either one or both of these.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

P. K. LUCKE has gone to Cuba and Costa Rica.

GEORGE F. BRIDGER has returned to Los Angeles from Miami, Arizona.

J. B. RISQUE has resigned as manager for the Tennessee Copper Co.

E. E. FREE of Baltimore is examining potash deposits near Blair, Nevada.

R. B. LAMB is in Nevada and California and will be away from New York for two weeks.

B. S. BUTLER is investigating the Cottonwood districts of Utah for the U. S. Geological Survey.

W. C. OREM, general manager for the Nevada-Douglas Consolidated Copper Co. is visiting the mines.

CHARLES B. CROKER is examining the Alvord mine north of the Calico district for Los Angeles people.

J. A. WILKINSON has been elected president of the Chemical, Metallurgical and Mining Society of South Africa.

ROSCOE EDVYAN will leave the Messina Transvaal Development Co. in South Africa, when his contract expires on Sept. 16.

A. G. DE GOLYER, formerly of New York, has been appointed general manager for the Vernon Mining Co. at Ironton, Colorado.

J. L. BRUCE, general manager for the Butte & Superior, was recently operated on for appendicitis, at Rochester, Minn., but has returned to Butte.

G. H. WOHLHAUPTER, formerly with the Utah Copper Co., will conduct flotation experiments for the Stimpson Equipment Co. at Salt Lake City.

JAMES A. LEWIS, JR., assistant chief engineer for the Calumet & Arizona, was severely injured on the 1300-ft. level of the Junction mine on August 16.

HARRY HUNTINGTON MILLER, manager for the Compañía Anónima Minera Lo Inceñible, El Callao district, Venezuela, has resigned and is in Los Angeles.

CHARLES T. KIRK, state geologist of New Mexico, who has been in the Mid-Continent oil-field and in Yavapai county, Arizona, has recently returned to Albuquerque.

E. W. BELLARI, safety engineer of San Francisco, has returned from visiting the coal mines of Pennsylvania, and the iron and copper mines of Michigan and Minnesota.

N. H. EMMONS, 2nd, for 18 months assistant manager and for three years manager for the Tennessee Copper Co., has again been appointed manager, with residence at Copperhill.

JAMES MACNAGHTON, vice-president and general manager for the Calumet & Hecla Mining Co. will reside in New York. JOHN KNOX, general superintendent, will be in charge at Calumet.

W. EARL GREENOUGH, has resigned as managing director of the Marsh Mines Consolidated, of Wallace, Idaho, to engage in independent practice as consulting mining engineer with headquarters at Spokane.

Obituary

ALEXANDER FRASER, metallurgist at the plant of the Cia. Min. de Angelitas, Pozos, State of Guanajuato, Mexico, was killed on July 31 by revolutionists under Nateras. Fraser had been 20 years in Mexico. He was 48 years of age, and leaves a wife and two children in London.

THE METAL MARKET

METAL PRICES

San Francisco, August 23.

Antimony, cents per pound.....	14
Electrolytic copper, cents per pound.....	28.75
Pig lead, cents per pound.....	6.75—8.00
Platinum: soft and hard metal, per ounce.....	\$65—69
Quicksilver: per flask of 75 lb.....	\$77
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, August 23.

Antimony: 50% product, per unit (1%, or 20 lb.).....	\$1.00
Chromite: 50% and over, Loc. cars California, per ton, 13.00—16.00	
Manganese: 50% product, Loc. cars California, ton, 12.00—16.00	
Magnetite: crude, per ton.....	7.00
Molybdenum: 50% and over, per pound.....	0.60—1.15
Tungsten: 60% W.O., per unit.....	15.00

While optimism prevails at Boulder, Colorado, the Rare Metals Ore Co. at Rollinsville has reduced its tungsten quotations to \$10 per unit for 60%, \$8.50 for 50%, \$7.50 for 10%, \$6.50 for 30%, \$5.50 for 15%, and \$3.90 for 5% product.

Platinum bulletin of the U. S. Geological Survey has been issued; also that on bauxite and aluminum.

EASTERN METAL MARKET

(By wire from New York.)

August 23.—There is a good demand for last-quarter copper; lead has an easier tendency; spelter is dull, with second-hands weak.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Aug. 23.....	66.37
" 24.....	66.31
" 25.....	66.25
" 26.....	66.12
" 27 Sunday.....	66.10
" 28.....	66.50
" 29.....	66.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90
Feb.	57.32	48.15	56.74	Aug.	54.35
Mch.	58.91	50.61	55.89	Sept.	53.75
Apr.	58.52	50.25	54.37	Oct.	51.12
May	58.21	49.87	54.27	Nov.	49.12
June	56.12	49.02	53.64	Dec.	49.27

It might be said that the tone of the silver market is steady, a slight downward movement indicating little. Earlier in August, American offerings in London had shrunk appreciably, China was not selling, and supplies of metal were not forthcoming from other sources, resulting in less active business. Stocks in Shanghai have gained from 30,500,000 oz. and 17,000,000 Mexican dollars to 32,000,000 oz. and 116,000,000.

On August 27 the "Ecuador" took silver worth \$591,600, say 900,600 oz., from San Francisco to the Orient.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Aug. 23.....	28.00
" 24.....	28.00
" 25.....	28.00
" 26.....	28.00
" 27 Sunday.....	28.00
" 28.....	28.00
" 29.....	28.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.20	July	14.26
Feb.	14.16	14.28	24.62	Aug.	14.34
Mch.	14.11	14.80	16.65	Sept.	14.92
Apr.	14.19	16.61	18.62	Oct.	14.10
May	13.97	18.71	19.02	Nov.	14.75
June	13.60	19.75	27.47	Dec.	14.75

Dividends payable are, Calumet & Hecla, \$3.90, Alton, \$2.50; Magna, 50¢; Calumet & Arizona, \$2, and Quincy, \$1 per share. Tennessee Copper is being sued for \$950,000, the bank account having been attached.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Aug. 23.....	6.75
" 24.....	6.75
" 25.....	6.75
" 26.....	6.75
" 27 Sunday.....	6.75
" 28.....	6.75
" 29.....	6.75

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	3.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
Mch.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.37	8.27	Nov.	3.68
June	2.90	5.75	6.88	Dec.	3.80

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Aug. 23.....	9.75
" 24.....	9.50
" 25.....	9.31
" 26.....	9.37
" 27 Sunday.....	9.37
" 28.....	9.25
" 29.....	9.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.11	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mch.	5.12	8.10	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	16.01	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

The U. S. Geological Survey has issued its "Press Bulletin" on the production of spelter in the first half of 1916. Details are given of output, consumption, stocks, exports, imports, and smelter capacity.

Zinc ore imported into the United States in the period January-June 1916, was as follows, in short tons:

From	Quantity	Zinc-content	Value
Canada	12,663	5,187	\$314,524
Mexico	79,663	25,471	3,254,001
Spain	38,239	16,006	1,051,315
Italy	7,525	3,283	213,275
Australia	83,775	38,133	2,225,790
Other countries	9,780	5,827	\$99,160

*Including China and Japan.

Exports of spelter and sheet-zinc totaled 58,097 tons of domestic, and 20,197 tons of foreign metal.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds.

Week ending

Date.	Aug. 15.....	Aug. 22.....
Aug. 1.....	38.00	35.00
" 8.....	37.00	35.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.99	22.00	July	37.50
Feb.	39.00	60.00	29.00	Aug.	38.00
Mch.	39.00	58.00	29.00	Sept.	37.25
Apr.	38.90	75.00	141.00	Oct.	35.00
May	39.00	75.00	90.00	Nov.	35.00
June	38.60	90.00	71.70	Dec.	35.10

TIN

Prices in New York, in cents per pound.

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60
Feb.	39.76	37.25	41.60	Aug.	31.60
Mch.	38.10	48.76	50.50	Sept.	32.10
Apr.	36.10	48.25	51.49	Oct.	30.40
May	33.29	39.28	49.10	Nov.	33.51
June	39.72	40.26	42.07	Dec.	33.60

Tin is firm at 29 to 30 cents.

Eastern Metal Market

New York, August 23.

All metals except tin have advanced in price, and have been or are in strong demand.

Copper has advanced considerably on large foreign and domestic buying.

Zinc is higher with a good business done for foreign and domestic consumption, which has slackened somewhat.

Tin is a little lower but firm and quiet, the position being strong.

Lead has risen on active demand and sales to foreign and domestic consumers.

Antimony sales have been large and the price has advanced. Aluminum is quiet and dull at 58 to 60c. Sheets are quoted at 80 to 85c., two to six weeks' delivery.

In the steel market, pig-iron is now the leader and buying has been on a large scale, particularly steel-making grades. Enormous orders for shell and other war material, with deliveries running 6 to 10 months ahead, have been booked, and it is evident that the Allies want much more steel from this country. The recent increase in domestic buying leaves the total shorter than some steel producers expected. There are signs in the building trade that high prices for steel are not to retard new structures, and car re-building is a factor rather than new cars, orders with 25,000 to 30,000 tons wanted for the former. Prices generally are stiffening.

COPPER

The rumors reported last week of large inquiries from both foreign and domestic sources have developed into an extensive buying movement, the amount involved being hard to determine. It is considered in some quarters that the 250,000,000 lb., estimated as the probable purchase of the Allies to cover their requirements, during part at least of the next six months, has already been arranged for and that at least 25,000,000 lb. has been sold for domestic account. In any event the purchases have been large for last quarter and near-by delivery and prices have advanced sharply, rendering the market very strong. Spot electrolytic yesterday was hard to buy, and was quoted at 27c. cash, New York, with Lake ingot nominal at 27.25c., also an advance. At present the market is quieter with consumers apparently well covered. Sellers dominate the situation and they are disinclined to make any concessions. Some sales are reported for early 1917 delivery. Electrolytic for last quarter is obtainable at 26 to 26.50c. The rush to provide for needs has brought the market back to the high prices of last May. The London market yesterday was £127 against £126 last week. August exports so far are 22,544 tons.

ZINC

The activity that characterized the early days of last week soon resulted in extensive buying on the part of foreign and domestic brokers, brass mills and perhaps second-hands. The price advanced accordingly until prompt metal was quoted yesterday at 9.75c. New York, and 9.50c. St. Louis, with last quarter at about 1c. per month below these prices. Just now demand has slackened, and the market is quieter but firm. It is thought that there is less metal in second-hands, and that producers are in a better sold up condition than when the last advance was manifested. A feature of the week's business has been the buying of large quantities of high-grade spelter that has been a drug on the market for some time. The recent spell of buying has been well distributed among users of prime western, brass special, intermediate, and high-grade metal. Exports to August 22 were 6990 tons.

Some interest has been manifested in the announcement that Great Britain has entered into an agreement with Australia to take 100,000 tons of zinc concentrate and 45,000 tons of

spelter yearly for the period of the War and for 10 years thereafter. Full details have not been made public.

LEAD

The spurt, which was noted early last week, developed into a heavy demand from all quarters, and sales are estimated by one broker to have attained an aggregate of about 10,000 tons last week. The buying was for foreign and domestic consumers, especially for prompt and August delivery. The latter circumstances was due probably to the fact that buyers' stocks had been decidedly depleted, necessitating their entry into the market. The demand grew until it attained such proportions that the outside price passed that of the A. S. & R. Co., which immediately raised its quotations on Thursday to 6.25c. per lb. New York. On persistent demand the same interest again raised its price to 6.50c. per lb. on Friday. It is believed now that sellers are pretty well sold-up, and that there is not much lead left for shipment within a month. For the first part of this week quietness has prevailed, with buyers refraining from climbing and sellers not inclined to sell. A small quantity is reported as having been sold at St. Louis as high as 6.55c., and a small lot at 6.65c., with special circumstances attending the latter transaction. One broker reports the leading interest as out of the market for early delivery metal. Another statement carries the conviction that the independents are better sold-up than they have been at any time since the boom in March and April, leaving the opportunity favorable for the big interest to raise its price again.

The general strength of the lead market is indicated by the rather high quotations on an inquiry for the Frankford Arsenal for 300,000 lb., the Nassau S. & R. Works, quoting 6.72½c. per lb., American Metal Co., 6.79c., Nathan Trotter & Company, 6.83½c., and Federal White Metal Co., 6.85c. It is noticeable that neither the A. S. & R. Co. nor the leading independent producers were competitors.

TIN

Quietness dominates the market, and there is a distinct absence of any excitement or any anxiety to sell or buy tin. The necessary protection of contracts or the covering of short sales has resulted in some business, but the tonnage involved has not been of large proportions. Despite the quietness, the week has been featured by steadiness in prices with no indications of easing anywhere. Yesterday Straits tin was obtainable at 38.50c. New York, and Banca tin at 37.50c. and steadier. Arrivals this month, including those for the 22nd, have been 3137 tons, with 3110 tons afloat.

ANTIMONY

The events of the past week have substantiated the speculation of last week that the bottom of this market had been reached at 9½c. duty paid, for since last week's report a steady advance has taken place and sales of 500 to 1000 tons are reported. The price has advanced from 10 to 10½c. duty paid, last week to 13½ to 14c. this week and the demand is good.

ORES

Antimony: The market is exceedingly quiet, with the last reported sales at \$1.10 to \$1.20 per unit.

Tungsten: The foreign demand is active and considerable business has been done. The demand comes from France and Russia, and it is reported that these countries have bought nearly 500 tons. Some sales of concentrate have been made at \$17 to \$19 per unit. Stocks, while still of fair size, are probably reduced 50% at New York and Pittsburg. Great Britain is said to have purchased 80 tons of concentrate in the last few days. Ferro-tungsten has declined until it can be bought as low as \$2.75 per lb. of contained tungsten.

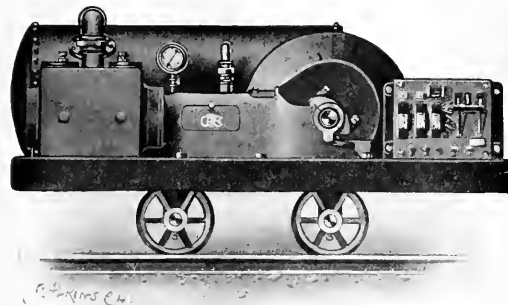
Industrial Notes

Information supplied by the manufacturers.

Portable Electric-Driven Air-Compressor

Compared with electric-driven coal-cutting machinery pneumatic equipment is cheaper in first cost; it is also safer. In order to present means of securing the fullest benefits of compressed-air machinery in electric-equipped mines, the Chicago Pneumatic Tool Co. has developed a portable, self-contained, electric-driven air-compressor, known as the 'Class N-SE Mine-Car.' In economy the unit compares favorably with a central compressor-plant on the surface. Its initial efficiency is of course not as high, due to its smaller capacity; but this difference is, in an appreciable degree, equalized by the losses resulting from leakage and drop of pressure in the pipe-line of the large plant; also, the portable compressor may be run close to the work so that the temperature of the air delivered to the drills, etc., is considerably increased. Feeder pipes are eliminated, often a considerable saving.

The compactness of this mine-car compressor is evident from the illustration. The unit consists of a horizontal,



PORTABLE ELECTRIC-DRIVEN AIR-COMPRESSOR.

straight-line, single cylinder air-compressor, driven by means of a motor through the medium of herring-bone gears. An air-receiver of proper size and a rheostat are provided. The entire apparatus is mounted upon a strong, but light, steel-car frame. The air-cylinder is fitted with the company's patented and efficient 'Simplate' inlet and discharge-valves. Necessary fly-wheel effect is secured through the rotation of the heavy gear. The positive splash system of lubrication is employed. Gears work in a bath of oil. Every part of this compressor unit is completely enclosed. Exposure to dampness will not injure it. Delicate or complicated features of construction have been avoided, and the machine is well suited to rough and heavy duty. It is so entirely automatic in action that it requires no attendant. The comparative lightness of the car permits of its removal from the rails when desired. The machines are made in six sizes, ranging in capacity from 51 to 311 cu. ft. of free air per minute at pressures of 80 to 100 lb. The larger sizes will take care of 6 to 8 and the smaller 1 or 2 'hummer' drills.

Commercial Paragraphs

The HAMMOND IRON WORKS of Warren, Pa., has arranged for representatives in Cuba, Central America, Brazil, Argentina, South America, and the British Colonies.

The UNITED NAVAL STORES Co. of 130 Pearl street, New

York, announces that it is ready to supply all the different fractions of pine and hard-wood distillates to mining companies, engineers, universities, etc., for research work. Several well-known institutions have already been given such oils.

In its instruction book No. 16, of 144 pages, the SMOOTH-ON MANUFACTURING Co. of Jersey City, N. J., tells all about Smooth-On iron cements, iron paints, corrugated iron gaskets. The cements are chemically prepared iron compounds sold in powdered form, and used by mixing with water to the consistency of putty. All manner of repairs may be effectively made by its use. We advise engineers to secure a copy of this useful work.

An interesting 9-page pamphlet entitled, 'Why Highly Oxidized Red Lead is Superior,' by G. W. Thompson, chief chemist of the NATIONAL LEAD CO., has been published by that concern. For centuries red lead, Pb_2O_3 , has been used in paints for the preservation of iron and steel. The percentage of true red lead in red lead varies from 70 to 100. Anything under 100% is considered a mixture of red lead and unconverted oxide of lead, litharge, from which red lead is made. Much progress has been recorded in the manufacture of red lead in the last 25 years. One is an increased percentage of true red lead, another is that red leads are finer from better grinding. Notes on painting, quantities used, and results are given.

Book Review

MAKING MONEY MAKE MONEY. By H. L. Barber. P. 315. A. J. Munson & Co., Chicago, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$1.50.

A unique book in its excessive use of capitals for emphasis. The author contends that men of limited means should put money into shares of newly-formed companies, rather than into bonds or savings banks, and thus have the chance of making from 100 to 1000% annually instead of the 3 to 5% of the conservative investor. He holds that men of limited means are deluded by our leading financiers, who conspire to get all of the money of the country into their own hands, and to this end subsidize the great newspapers and influential magazines to preach the false doctrine that shares are dangerous and bonds safe. The complaint of the author that a conspiracy exists to conceal the large profits paid by common shares seems ill-founded, in view of the 'Blue Sky' laws of many States, and the flood of circulars and advertisements issued by brokers and promoters. He finds that "innumerable opportunities" exist for money to earn from 100 to 1000% annually, and on page 31 shows that an annual investment of \$100 at 100% will amount to \$2,300 in 10 years (the correct amount is \$102,300); at the end of 15 years the investor will be a multi-millionaire. The reviewer feels that stopping at 15 years would be absurd, for by continuing for 31 years the total becomes over \$200,000,000,000, or more than the aggregate wealth of the United States. On page 221 is a "typical case" of capitalistic greed—the Western owner of a mineral deposit containing several hundred million dollars, on applying to capitalists for half a million dollars for development was asked to give up the whole property in exchange for the promise of a permanent superintendency at \$150 per month. The reviewer feels that this is a "typical" prospector's dream, and bears no relation to hard facts. The author gives instances of the great profits made by the fortunate buyer of common shares: in 19 years \$100 invested in Postum Cereal Co. grew to \$20,097; and Gillette's Safety Razor \$100 shares expanded to \$52,000. These and other profits are enough to lead many sanguine readers to follow the advice on to fortune, but prudent readers will be governed by the fear that they may be unlucky enough to buy in one of the companies that fail—and 95% of all companies are said to fail—and prefer to keep their money in bonds or savings banks.—W. H. S.

EDITORIAL

T. A. RICKARD, Editor

PIG-IRON production is recognized as a barometer of industry; that of the United States is increasing. Final figures for the first half of 1916 show a yield of 19,619,522 tons, compared with 12,233,791 tons in this period of 1915, and 17,682,422 tons in the second part of last year. Ferro-manganese made a gain from 0.43 to 0.51% of the total, and spiegeleisen 0.33 to 0.45%. The demand for steel from the warring nations shows no sign of abatement.

EVERY man is entitled to have his name spelled correctly, and the correct spelling is the way he spells it himself. How does the inventor of a famous roasting-furnace spell his name? The good people who use his furnace at Anaconda call it MacDougall, as shown in the excellent pamphlet recently issued; Mr. L. S. Austin makes it McDougal; Mr. T. T. Read spells it McDongall; while the A. I. M. E. volumes give both McDougall and MacDougall. Finally, the manufacturer of the furnace uses McDougall. We should like to hear from the gentleman himself, or his heirs and assigns, as the final authority on the matter.

METALLURGICAL results at the Ouro Preto gold mine in Brazil show careful work. The lode is a quartzose replacement in schist, the gold being associated intimately with arsenical pyrite. On ore averaging \$7.30 per ton the extraction is 91.41%, the total loss of metal from all sources being 60 cents per ton. Last year 85,400 tons was treated. At the sand-plant, the 63,206 tons leached averaged 88 cents per ton before treatment, of which 59 cents was recovered. Slime assayed 92 cents, giving a recovery of 80.6%. The combined cost of sand and slime treatment was only 23 cents per ton. These are excellent results from such low-grade material, with such a comparatively small tonnage, and are a credit to the superintendent, Mr. A. J. Bensusan, and his staff. Total costs amounted to \$6.10 per ton.

SHIPMENTS of copper from Chile and Peru to United States refineries continue to increase, due mainly to operations at Cerro de Pasco, Chuquibambata, and Braden. For the eleven months ended May 31, 1916, exports from these countries were 51,279,639 and 64,956,459 pounds, respectively, a total of 116,236,098, compared with 67,530,320 and 55,684,377 pounds for similar periods of the previous two years. Contemplated additions to these properties in the near future will augment the output considerably. The Chile Copper Company's yield in the first half of the current year was 19,724,385

pounds. In future this company will issue monthly statements. A new estimate of ore reserves places the total at 354,130,660 tons, averaging 2% copper. This is an increase of 50,000,000 tons since April 1915.

WE hope it is true that cotton-stalks can be used for making paper-pulp, as reported from Berlin, for the price of that commodity has risen uncomfortably. The use of thick paper for lining the trenches from the Channel to Switzerland is given as one cause, although paper wadding is no longer used in rifles. Imports of rags for paper manufacture have declined to nearly one-quarter what they were before the War. But the waste of paper in this country is reason enough for a scarcity. The bulky issues of a cheap and misinforming daily press indicate where the paper goes. An effort to reduce the number of pages has been made by several dailies in the East. As Thomas H. Price says in *Commerce and Finance*, "The average daily newspaper prints too much stuff. There is not enough attention given to editing. Condensation is not the art it used to be." This is true of the technical journals also. Quantity is attained at the expense of quality. The public is not critical and thinks it is getting more for its money when a paper is bulky and un-edited than when it is given matter that has been condensed and revised carefully.

GOLD output of the Rand in July was practically the same as in June, namely, 761,000 ounces. The current year will probably make a record. We have just received the annual report of the Transvaal Chamber of Mines covering the year 1915. It is less voluminous than the previous statement, but contains a number of interesting items. At the gold mines, an average of 22,081 whites and 193,687 Kaffirs were employed, earning £6,283,884 and £6,041,090 respectively. There were 5675 machine-drills operated. The crushing of 28,314,579 tons of ore, averaging \$6.30 per ton, was accomplished by 9990 stamps and 321 tube-mills. The working cost averaged \$4.18 per ton. The total yield was £37,264,992, equal to 40.1% of the world's total gold production in 1915. Dividends amounting to £7,619,416 were distributed. The Transvaal also produced 5,202,805 tons of coal, and diamonds worth £128,067, this small amount being due to the fact that the Premier mine was closed. Incidentally we note in a consular report from Johannesburg that a new diamond field has been discovered six miles from the Premier, but the extent of it is not yet known. Copper ore valued at £108,667 was also produced, and tin ore worth £337,188. Taxes totaled £1,877,452. A committee for the Chamber has completed

four dust-sampling surveys of the mines, a work of great utility. The staff is to be increased, so that every mine may be sampled once every two months. Stores purchased by all companies amounted to £10,889,115. At Johannesburg, on June 8, a conference of the councils of nine South African technical societies was held to start a movement for the furtherance of scientific research in the Union. As these are all live institutions, some good results may be expected.

NEW capital to the amount of £1,978,986,200 has been issued in London since the War began. Mining, financial, and commercial enterprises have suffered a great slump; of the total amount of new capital issued for all enterprises, only £102,694,300 was invested in this direction. Increases in the capitalization of existing companies amount to £95,828,700, which leaves little for fresh enterprise. Mining seems to have been the chief sufferer. During the period of peace from August 1913 to August 1914, £5,733,200 was invested in mining enterprises. This amount has dwindled to £1,841,800 during the first, and £516,500 in the second year of the War. The flow of English capital to foreign countries for the development of mines has practically stopped. The United States seems to have become, at least temporarily, the banker for the nations. Foreign loans and credits made in the United States since the War total \$1,764,950,000. This includes the new War loan of \$250,000,000 to England, while \$1,115,000,000 represents the total loans to Canada, England, France, and Russia, all for War purposes. In the meantime, our friends in South America have not been neglected, Argentine having received \$68,500,000, Chile \$6,000,000, and Bolivia \$1,000,000.

MINING in the Coeur d'Alene cannot boast the nearly three score and ten years of the Californian gold mines, nor the nearly 50 years of operation of its chief competitor, the lead district of south-eastern Missouri. Compared with copper-mining in Michigan or silver-mining in Nevada, the great mineral region in the panhandle of Idaho is only in its youth. Mining of placer gold in the Coeur d'Alene was begun in 1882 by A. J. Priehard, and the lead-silver deposits were staked several years later. "Thirty years ago," says Mr. William Wagner of Wallace in his new handbook on the Coeur d'Alene, "the district was uninhabited except for a few daring prospectors, and the Indians, who came to hunt and fish." Mr. Wagner continues, "nowhere can be found a mining district more favored by nature. There is an abundance of fresh water; the hills are well timbered, supplying cheap lumber; electric-power lines are built and railroads have been extended to the big mines." During 1915 the Consolidated Interstate-Callahan, a zinc mine, made the greatest profit in the Coeur d'Alene, \$2,921,487. The Bunker Hill & Sullivan won a profit of \$1,145,851, and the three companies under the same management, the Caledonia, the Ontario, and the Sierra Nevada, made profits of \$761,797 and \$223,724, and \$46,-

354, respectively. The Federal Mining & Smelting Company, which is a subsidiary of the American Smelting & Refining Company, made \$571,560 from its Morning mine, besides smaller amounts from the Last Chance and Standard properties, while its Frisco and Iron Mountain mines made no profit. The Greenhill-Cleveland Mining Company, controlled by the Federal company, cleared the sum of \$497,864. The Hercules Mining Company and the Tamarack & Custer, which are controlled by the Day family, made profits of \$1,096,019 and \$346,796 respectively. The Success Mining Company, also owned in the North-West, won \$898,935 in profit. The Hecla and Stewart companies made nearly identical winnings, \$593,680 and \$572,231 respectively. The Gold Hunter Company made a small gain, and a dozen other operators shipped ore without financial advantage.

ELECTROLYTIC zinc will be an Australian product in the near future. We learn by mail that the Amalgamated Zinc (De Baxay's) Company has contracted with the government of Tasmania (the island State) for a supply of electric power, the first unit of 4000 horse-power to be available by January 1918, or earlier if desired. It will be remembered that the Amalgamated Zinc operates at Broken Hill, in New South Wales, buying zinc-lead-silver tailing from the mining companies, treating it by flotation (at the rate of over 40,000 tons per month in normal times), and making a concentrate containing 49% zinc. Since the War began, this company has had some difficulty in disposing of its product, much of which came to American smelters. It is the desire of Australians to treat their output of ore and concentrate within the Commonwealth. As the Tasmanian government has recently acquired a hydro-electric plant capable of considerable expansion, permitting low rates for current, and as electrolytic zinc production is a success in the United States, the Amalgamated Zinc no doubt felt that it could go ahead and treat its concentrate by this method. This company's general manager, Mr. H. W. Gepp, has investigated practice in this country. The Electrolytic Zinc Company of Australasia has recently been organized with a capital of £1,000,000, backed by Amalgamated Zinc, for the production of electrolytic metal. While on this subject it may be said that in the west coast region of Tasmania there are several mines containing refractory ores. A smelter operated at Zeehan for a time, but unprofitably. A good deal of ore was sent to Europe for treatment. Recently the Mount Lyell company completed its option on the Mount Read and Roschery mines, which are estimated to contain 800,000 tons of ore averaging 29% zinc, 7.5% lead, and 9.5 oz. silver, and \$2.50 gold per ton. It is probable that, in addition to concentration of this ore, electrolytic treatment of the concentrate will follow. The Mount Lyell company has installed hydro-electric power-plants near its own copper mines at Queenstown, dispensing with steam. Tasmania is capable of large development in water-power, and is destined to become the laboratory of Australasia.

The Lid Unlocked

The weakness of the Government has been betrayed so that all the world may see. Any minority, any class or group of men, fixed in their determinations as we know trade-unions to be, can work its will. The railroad engineers and trainmen are too intelligent a class to wish to expose the country to the peril of dominance by the great hordes that are ever ready for the plunge into anarchy, but they have betrayed the fatal secret. The pious pacifists have had their way, and the nation of a 100 millions has an army such as was deemed necessary when we numbered 20 millions. We were going to have our way by force of moral suasion. That has just been subjected to trial, and we see that might rules, as usual. We have had to recognize that the ultimate police force of the country is insufficient to compel the settlement of industrial disputes within their proper sphere. Four hundred thousand men, through their four spokesmen at Washington, command the representatives of 100 million people, and are obeyed. An ultimatum is hurled; a narrow time limit set; and the dignity of the nation is humbled to comply with the mandate.

No regret need be felt that the railroad men are to have an 8-hour day without reduction of wage. It is to be supposed that the public can afford to pay the bill. It will mean such a vanishing fraction of a mill per ton-mile of freight moved that the only serious evil that might flow from it would be the excuse it might give to merchants for raising prices out of due proportion to the actual increased cost. We do not grudge the laboring man his just reward; our regret is that the discovery should have been made that neither he, nor you, nor we can count so hopefully as we did upon the future security of our Government with its guarantees of life, liberty, and equality of right to seek and enjoy the fruits of the earth.

The decision of the railroad engineers and trainmen to call a strike was pregnant with evil. Equally may it be said that the refusal of the railroad managers to accept the 8-hour day as a basis for negotiation of the other points at issue was an act of folly. They have added to the indignity put upon the country. They acted more like a company of poker players than a body of far-seeing business men; they tried to win by a bold game of bluff, when all the world could plainly see that their opponents held the better cards. Both sides were guilty of trifling with that most sensitive of all explosives, the passion of the multitude. It is not necessary to reach a firm conclusion as to the merits of the case in dispute to be able to brand the entire performance as dangerous to the welfare of the country.

If the crisis presented by the action of the railway brotherhoods shall awaken the American people to the need of preparedness to meet the emergencies of the Republic in both civil and military spheres, it will have served a most useful purpose. The spectacle of the President of the United States working day and night to prevent an industrial strike, and of Congress con-

verting itself with feverish precipitation into a mere machine for legalizing the demands of the representatives of labor-unions, is not edifying, nor does it augur well for the future stability of industry and national development. It makes patent the indifference that Congress has displayed toward the great needs of the day. It provokes wonder as to what new dilemma may arise, unforeseen and unprovided for, where the whip of circumstances may be used to force hasty adjustments, which the nation may repent at leisure. Without expressing an opinion as to which side in this controversy possesses the larger measure of right, any citizen who believes in his country must feel pained at what has happened. The thing to which we cannot close our eyes is that the brotherhoods brought forward their demands at a moment when the pieces were so set on the national chessboard that refusal was impossible. This indicates, what so many have long feared, that the physical inability of our Government to maintain law and order has been measured with exactitude by the masses. England, because of military weakness prior to the European war, which has given a new direction to English thought and feeling, was dragged again and again to the verge of social revolution. Many able students of politics and sociology had pointed out that a foreign war would prove her speediest cure for the social ferment imperiling the existence of the Empire. We have witnessed the fruit of unpreparedness in Mexico, where a petty revolution headed by Madero, after capturing nothing more than a single port of entry two thousand miles from the capital, revealed to the people the impotence of the government, so that soon the flames of anarchy were sweeping the country and destroying the institutions built under the constructive statesmanship of Diaz. No doubt the virtue had been allowed to rot out of some of those institutions; no doubt reforms were needed; yet is it also true that the structure reared by Diaz had in it more hope for the future of all Mexico, for poor and aristocrat, than can be found in the ashes that remain after the social conflagration. Madero playing Pandora found the lid unlocked and pried it open; never since have the sprites of evil suffered it to be shut.

Is our political strong-box also unlocked, and is the power wanting to hold in check the unthinking spirits that would sacrifice the treasure of our institutions for the sake of fleeting revel in the debaucheries of political license, so bitterly seen in the excesses of the French Revolution? It is evident that the railroad brotherhoods found at least one chest with the lock off. Not only is our army pitifully inadequate to insure respect for the laws, but almost the whole of that army had been dispatched to guard the 1700 miles of our southern boundary. Interruption of traffic for a few days would reduce these forces to destitution and practical helplessness. In such a situation the chances of renewed difficulties with Mexico would have been intensified. The folly of concentrating nearly our entire military strength on the border, and the certainty that it would

give rise to strikes, was pointed out in many quarters at the time. The action of the railroad brotherhoods has justified the warning then sounded.

That the brotherhoods took advantage of the situation is not cause for condemning them. They did what business men are daily doing in the smaller affairs of individual commercial warfare. They have merely discovered the opportunity for successfully forcing the hands of those with whom they were dealing. The declaration in the strike-order against the use of violence counts for nothing. No body of men could hope to win in such an industrial battle by merely quitting work and permitting others to be substituted in their places. Coercion is an essential part of these industrial protests. A government that was prepared to restrain the strikers from committing excesses through riot and arson could stand by and suffer the parties in interest to come to their own conclusions, while at the same time protecting the general welfare and rights of the public. Instead of that, the whole Administration and both houses of Congress are thrown into a panic, and half-baked legislation is turned out over-night to grant the 8-hour day, with provisions to protect in some measure the rights of the railroads and the general public, all of which may be upset by the Supreme Court, provoking new issues as perilous as those that for the moment were averted.

This same Congress, that has just been passing a niggardly appropriation for an utterly inadequate increase of the Army, is now compelled to put on a subservient Chinese grin at the behest of the calmly confident chiefs of the brotherhoods, and do their bidding! It may be better than to let the social pot boil over; the sympathetic strikes that would have accompanied the railroad walk-out might easily have let loose the barbarian element in society, imperiling the very foundations of the Republic. We may not forget what happened not many years ago at the Bunker Hill & Sullivan in Idaho, nor the social war and terrorism in Colorado, nor the display of the ugly side of human nature in the Pennsylvania coal strikes, nor the brutalities that suddenly thrust themselves above the erstwhile peaceful surface at Youngstown, Paterson, Lawrence, and Homestead.

The American people should learn from this lesson, and consider well the amelioration of industry by appropriate enabling legislation while there is time to work out the equities of the social problems involved, and meanwhile create a strong arm to insure order and respect for law in every emergency in order to prevent the destruction of those institutions under which men have found freedom and opportunity for generations. Imperfect many of these institutions may be, but they have been winnowed from the experiments and conscientious efforts of men who have mostly been true patriots, and who have shown superior genius for developing a sane and wholesome democratic government. These institutions may not be lightly endangered, for they represent the fruit of rational evolution. When the lid is off it is not the people that rules, it is not the national con-

science that dictates, but the passions of an unscrupulous minority. Neither is it when the lid is off that the poor obtain justice and opportunity. Behold Mexico, if anyone doubt! Consider, moreover, that two small minorities, so unlike in character and traditions that they could no more mix than can oil and water, are the ones that clamor against military preparedness—the pious fanatics called ‘pacifists,’ and the socialistic brotherhoods.

Cyanidation of Silver Ore

At Rochester, Nevada, the latest developed silver-gold district in that State, there are two cyanide mills in operation. In our issue of August 28, 1915, the plant of the Rochester Mines company was described by Mr. G. W. Wood; in the present issue that of the Nevada Packard Mines company is described by Mr. Herbert G. Thomson. The Rochester mill is a typical equipment of the continuous counter-current decantation system, known briefly as C. C. D. Thickeners are used exclusively without a filter. The ore is crushed in solution by heavy stamps, and is finally reduced in tube-mills so that 94% passes a 200-mesh screen. Following this, the pulp is agitated, thickened, and decanted in a series of vats. As custom ore is treated, no figures of cost are available for this 120-ton mill, which is being duplicated.

The Nevada Packard 100-ton mill was erected in 1915 at a cost of \$65,452, compared with the estimate of \$65,740 made by the designer, Mr. Knud Freitag. The ore is described as highly-altered sericitized rhyolite, of varying hardness, traversed by quartz veinlets. Cerargyrite, the chloride of silver, is the valuable constituent. The content ratio of gold to silver is 1:300. After being crushed to 1½-inch size the ore is further reduced to ¾ inch by rolls. Fine-grinding, so that 83.3% passes 200-mesh, is done by successive reduction in two short tube-mills, working in closed circuit, with a duplex classifier. This scheme has proved entirely satisfactory. The first contact of the ore with cyanide solution is at the No. 1 tube-mill feed-box. Selected lumps of rhyolite have largely replaced Danish pebbles, to the gain of efficiency and economy. The spiral pumps used are considered superior to bucket-elevators or air-lifts. From the thickeners the pulp goes to agitators, where most of the cyanide and lead acetate are added. Interesting data were secured on the use of lead salts. From the agitators the pulp flows to thickeners, it is then diluted with barren solution, and partly treated by the C. C. D. system. The underflow from the thickeners is finally dewatered on a filter of the revolving-drum type. The soluble loss per ton treated is 5 cents, an excellent result due to counter-current wash and the heavy water-wash on the filter. The total cost of treatment is \$1.26 per ton, and the recovery is 94.9%. A comparison of crushing and treatment at the two plants at Rochester shows considerable differences. The variation from Tonopah practice is also noteworthy. Mr. Thomson gives some useful hints on building construction and cost of installation.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

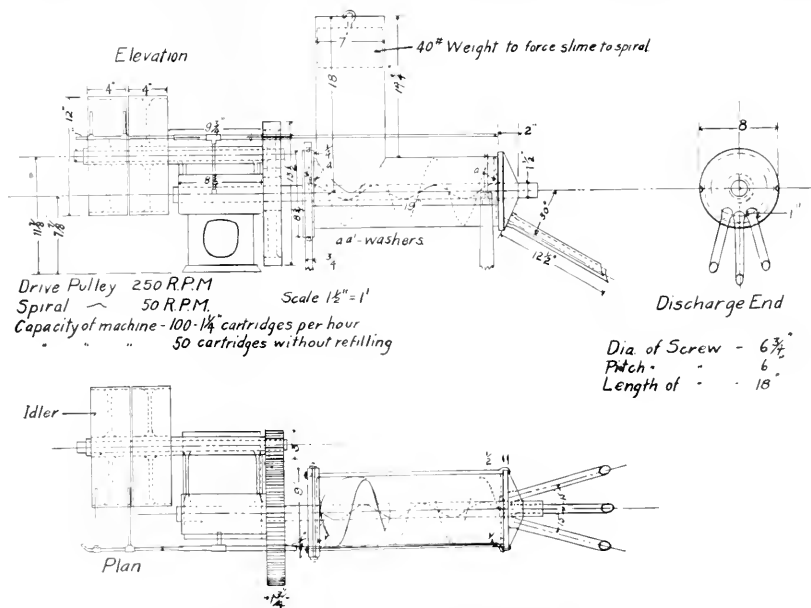
Modern Blasting Practice

The Editor:

Sir—The benefits of careful tamping (or stemming) have been so fully brought out in the paper* by Walter O. Snelling and Clarence Hall, and emphasized by E. A. Collins† and P. B. McDonald‡ that there seems little reason for its not being more generally adopted. The present high price of explosives offers a special inducement

with hard ammonia powder is little, if any, more difficult than where soft gelatin powder is used. It has been noted that the chief difficulty in introducing the practice of tamping is the lack of suitable material furnished in convenient form to the men who load the holes. If the tamping material is furnished in specially marked cartridges, which are as easily loaded as a stick of powder, there is little difficulty in getting it used.

The tamping-bags, now being furnished at small cost



ment to reduce the quantity of explosives used and at the same time to substitute, where possible, cheaper grades having approximately the same strength as the corresponding gelatin powders.

The conclusion drawn from the tests made by the U. S. Bureau of Mines, that both these economies can be effected by careful stemming, have been verified in the practice at Mogollon. With plenty of suitable tamping material on hand the loading of back holes, in stoping,

by some powder companies, have undoubtedly tended to increase the practice of tamping. However, the filling of the bags by hand is slow and unsatisfactory. To overcome this we have introduced at Mogollon a simple machine for filling the bags, which is outlined in the accompanying drawing. The empty bags are slipped over the spouts on the end of the machine and the movement of the spiral forces the material into the bags, causing them to slip off from the spouts as they fill. A tight and loose pulley and belt-shifter add to the convenience in operating. That such a machine can be improvised at almost any mine is indicated by the fact that the one

*Technical Paper 17, U. S. Bureau of Mines.

†'Efficiency of Tamping,' M. & S. P., May 22, 1915.

‡'Modern Blasting Practice,' M. & S. P., May 27, 1916.

shown was built, under the direction of D. L. Perkins, mill superintendent, mostly from material recovered from the scrap-pile.

At the Last Chance mine of the Mogollon Mines Co. the factors affecting the amount of ore broken in stoping are the width of the vein and the character of the vein filling. In the wider stopes, up to 14 and 18 ft. wide, there is a large amount of calcite present, permitting deep holes to be drilled, while in the stopes 5 to 10 ft. wide the relative amount of calcite is usually less and the silicification greater. Between these extremes the ore broken in stoping varies from 16 to 8 tons per drill-shift, or from 1 to $\frac{1}{2}$ tons per lb. of powder. In any stope where conditions have remained the same there has been no decrease in the quantity of ore broken per drill-shift when tamping material has been substituted for the last stick of powder in loading holes. The number of tons of ore broken per pound of powder has shown a proportionate increase, and the cost of explosives per ton a corresponding decrease.

S. J. KIDDER.

Mogollon, New Mexico, August 21.

[The high price of dynamite as a consequence of the War has caused many mining companies to experiment with lower-grade explosive but using stronger detonators, thus substituting say 40% powder for 60%. Results have been successful.—Editor.]

A Traveler's Library

The Editor:

Sir—In the August 12 issue 'Subscriber' wishes to solve a problem that has worried every conscientious engineer who has traveled extensively. Personally I have found a filing method based on Carl A. Allen's admirable extension of the Dewey indexing system to be of great value, and have used it as the most suitable receptacle for all of my notes and many text-books which I have unbound and distributed through the files. Therefore, knowing where I am going and the general nature of the work to be done, I can take as many envelopes (11 by 14 in. fibre) as I find necessary to cover the work in hand. Later, if I find that I need more data, I have only to write to the office for the required envelopes, giving their numbers, and so get them in a reasonably short time.

In conjunction with the files I suggest the following books:

Hütte's 'Das Ingenieurs Taschenbuch,' 3 volumes, with Flügel's dictionary English-German and German-English; Hoover's 'Principles of Mining;' Finlay's 'Cost of Mining;' Gillette's 'Cost Data;' American Institute of Mining Engineers index to all volumes; a good book on therapeutics and Materia Medica, and a good book on theory and practice of technical writing, followed by a choice of the following subjects: surveying, assaying, metallurgy, chemistry, geology, mineralogy, prospecting, and sampling.

This will make 17 volumes in all, besides the file en-

velopes, all of which may be packed with room to spare for the card index in a box 11 $\frac{1}{2}$ in. wide by 14 $\frac{1}{2}$ in. deep by 30 in. long (all inside measurements). Such a box made of $\frac{3}{4}$ -in. ash or oak, with dove-tailed corners, a hinged cover, and padlock, will last from 6 to 8 years, and can be made water-tight by including two thicknesses of heavy canton flannel between all joints and the application of new electrician's tape around the joints of the cover from time to time.

In addition to this, an engineer should remember the service of the A. I. M. E. Library Bureau.

JOHN B. STEWART.

Waxhaw, North Carolina, August 17.

Prospecting

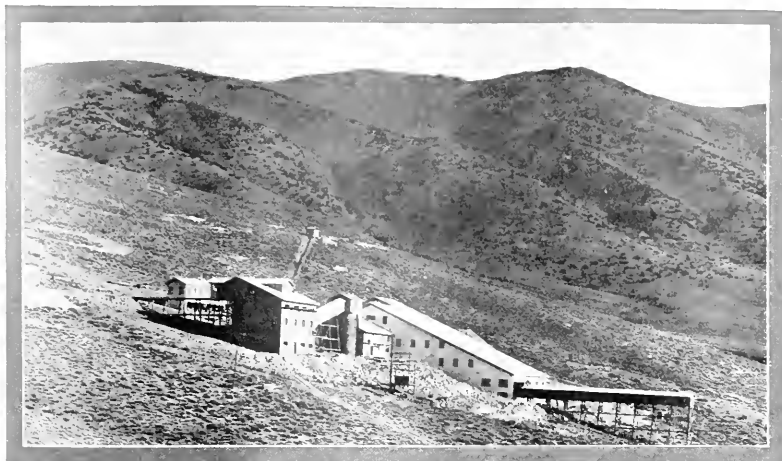
The Editor:

Sir—I quite agree with Mr. Platt's article in the August 12 issue as to the absurdity of Mr. French's assumptions. Mr. French is unjust to the prospector. While not disparaging the value of an engineer's services, I would sooner pay a good prospector \$250 per month and the engineer \$90 while looking, or prospecting, for a mineral deposit. My long experience in this work makes me feel that way. After a mine is opened, with considerable ore, I would employ an engineer to examine it, make assay-plans, etc., and advise on a treatment process. Mr. French rewards two prospectors with \$1000 if they find a rich mine, while the engineer, who probably could never find one, is to receive shares in the company. Mr. French does not know the real old-time prospector, or he would not talk in this manner. Since large mining companies will buy only properties showing a certain amount of ore—and they are right in this—I would suggest that a small company be organized to lease and bond one or more promising prospects, of which there are many owned by prospectors, who have done a good deal of work on them. With \$5000 judiciously spent, not in high salaries for engineers, probably a good mine would be opened without having to spend time and money searching for it first. Given \$5000 I could do this now.

M. F. GRAUPNER.

Butte, Montana, August 16.

TUNGSTEN in Japan is worth \$1300 per ton for 65% product, or \$20 per unit. In seven months, shipments to the United States total over 400 tons. The monthly output of Japanese and Korean mines is about 150 tons. At Rollinsville, Colorado, the Rare Metals Ore Co. is paying the following for tungsten ore: 1% ore, \$2 per ton; 1 $\frac{1}{2}$, \$1.50; 1 $\frac{3}{4}$, \$6; 1 $\frac{1}{2}$, \$7.50; 2, \$10.50; 3, \$25; 4, \$35; 5, \$45; 6, \$55; 7, \$65; 8, \$75; 9, \$85; 10, \$95; 15, \$150; 20, \$200; 25, \$250; and 30%, \$300 per ton. The tungsten situation at Boulder is brighter, according to Eugene Stevens, of the Rogers mines, who recently sold a lot for \$20 per unit. It is reported that users of tungsten will not make any time contracts, and will not order ahead for 30 days.



THE NEVADA-PACKARD MILL.

Construction and Operation of the Nevada Packard Mill

By Herbert G. Thomson

INTRODUCTORY. The cyanide plant of the Nevada Packard Mines Co. is situated at Packard, in Humboldt county, Nevada, four miles from Rochester and nine from Oreana, the nearest Southern Pacific railroad point. The Nevada Short Line narrow-gauge railroad runs within four miles of the property, but the combined rail and wagon transportation charges for supplies from Oreana are the same as the all-wagon haulage-rate from that point, \$8.75 per ton.

The ore is a remarkable one. It is essentially a highly altered sericitized rhyolite, varying from a soft and friable talcose or schistose product to an extremely tough silicified variety. The rhyolite is traversed by occasional stringers of quartz. Cerargyrite is the valuable constituent of the ore. Sulphides occur sparingly, while sulph-antimonates or arsenates are extremely rare. The ratio of gold to silver is about 1:300. In places small quartz veinlets carry a much higher proportion of gold, giving a string of colors when panned. Preliminary tests showed the ore to be easily amenable to cyanidation. Briefly, the process consists of crushing dry in rolls, grinding in tube-mills, agitation, and modified counter-current decantation followed by filtration.

CONSTRUCTION. The mill was designed and erected by Knud Freitag, who remained as superintendent for several months after the completion of the plant. The mill is directly below the portal of the lowest adit. In order to allow sufficient room at the bottom for the disposal of

tailings, it was necessary to house the tube-mills in an addition at the side of the main building. The slope of the mill-site is about 15°, allowing most of the pulp-transference to be done by gravity. The crushing-plant is situated 80 ft. from the mill. Construction of the mill started on August 12, 1915, at which time three-quarters of the excavation work was completed. Operations began on December 4, 1915. The usual 'timing-up' process was conspicuous by its absence. In excavating for foundations, 5200 tons of material was removed, a large part being hard rhyolite, so that 1000 pounds of dynamite had to be used. All foundations are of concrete. The main building is 64 ft. wide by 144 ft. long. The tube-mill addition is 40 by 42 ft., and the crushing-plant 24 by 32 ft. In all, 220,000 ft. B.M. of lumber was used in the mill-construction. Oregon pine was used for the framing, while the roof and sides were built of 1-inch fir boards covered with J. M. asbestos roofing. The Oregon pine was furnished by the C. F. Smith Lumber Co., the siding, roof, and flooring by the Red River Lumber Co., and the heavy timbers for the crushing-plant by the Sierra Nevada Wood & Lumber Co. The asbestos covering has proved an excellent non-conductor of heat. With a temperature ranging from 10° below to 110° above zero, this becomes an important feature.

The entire mill-frame presents a neat and finished appearance, and the observer is highly impressed with the clean-cut and workmanlike manner in which attention

has been given to every detail of the construction. Due consideration has been given to the proper design of all members of the structure, without the use of an excess of material. There is a notable absence of useless or over-size timbers, without loss of the necessary strength and rigidity. Another feature is the use of butt-joints and corbel (Fig. 1) for joining stringers, instead of the usual splice-joint (Fig. 2). The use of this joint means a saving in labor, both in framing and erecting. The splice-joint, of course, is used in all trusses. The thickener and agitator mechanisms are suspended from the trusses, as well as the transmission machinery. Good clearances have been provided around all machinery and tanks, and every part is easily accessible. Floors are constructed around all tanks. Runways are built around and alongside all the mechanical appliances. Belts and transmission parts are overhead and well guarded in ac-

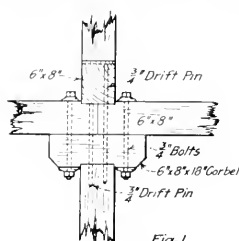


Fig. 1.

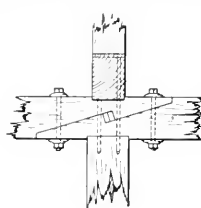


Fig. 2.

DETAILS OF BUTT AND SPLICE-JOINTS IN BUILDING.

cordance with safety-first ideas. Circular steel ore-bins furnished by the Western Pipe & Steel Co. were used instead of the ordinary wooden bins. The first cost of this type is about half of that of wooden bins of the same capacity. The entire equipment was selected with one object in view: to obtain the highest metallurgical as well as mechanical efficiency. All purchases were made from manufacturers of high-grade material on competitive bids based on complete detailed specifications submitted by the constructing engineer. No material was purchased because it was "good enough" or cheap, as experience has proved that this manner of selection means grief for the operators.

The selection of high-grade machinery does not necessarily mean high first cost of mill, as has been shown at Packard. However, it does mean low costs of operation and maintenance.

The original estimate furnished by Mr. Freitag called for \$65,740. The final cost of the completed mill was \$65,451.94 divided as follows:

Equipment (machinery, supplies, etc.)	\$38,765.34
Grading (material, labor and teams)	4,213.05
Concrete (material and labor)	1,738.48
Framing (material and labor)	10,096.57
Construction (material and labor)	9,093.50
Engineering	1,545.00
Total	\$65,451.94

As carefully segregated costs were not kept until the actual construction work began, more detailed figures are

not available. However, the complete labor costs, exclusive of teaming, grading, and excavating, which work, as previously mentioned, was nearly completed when the erection of the mill started, may be of interest.

Mill construction (framing and erecting):

305.5 shifts at \$4.	\$1,222.00
683.75 " " \$5.	3,418.75
84 " " \$6.	504.00
	\$5,142.75

Pipe work:

73.5 shifts at \$4.	\$ 294.00
43 " " \$5.	215.00
	509.00

Crusher plant ore-bins:

13 shifts at \$4.	\$ 52.00
6 " " \$5.	30.00
	82.00

Mill ore-bins:

9 shifts at \$4.	\$ 36.00
15 " " \$5.	75.00
	111.00

Painting:

9 shifts at \$4.	\$ 36.00
	36.00

Concrete:

58 shifts at \$4.	\$ 232.00
49.25 " " \$5.	246.25
	478.25

Electrical equipment:

31 shifts at \$4.	\$ 124.00
51.25 " " \$5.	256.25
	380.25

Erecting tanks:

22 shifts at \$4.	\$ 88.00
36 " " \$5.	180.00
	268.00

Erecting Oliver filter:

35.5 shifts at \$4.	\$ 142.00
27 " " \$5.	135.00
	277.00

Installing machinery (not included under above headings):

132.25 shifts at \$4.00	\$ 529.00
24 " " \$4.50	108.00
195 " " \$5.00	975.00
	1,612.00

Watchman:

94 shifts at \$4.	\$ 376.00
	376.00

Total \$9,272.25

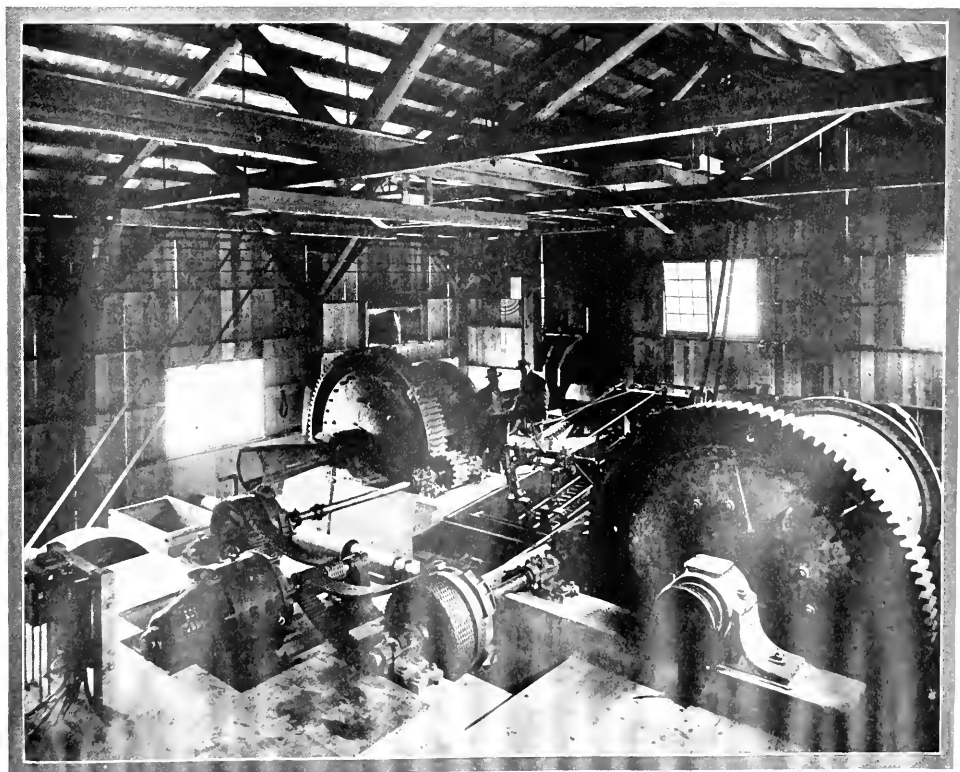
OPERATION. From the mine, the ore is trammed in one-ton Matteson cars to the crushing-plant, where it is weighed on a Fairbanks recording-beam scale, and dumped into one of two circular steel ore-bins, having a combined capacity of 100 tons. Lime is added at this point, usually one shovelful to every four cars being sufficient to maintain the desired alkalinity. The steel bins are each 12 ft. diam. by 16 ft. deep, constructed in four courses, with $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{3}{8}$ angle-iron reinforcements at top and bottom. The two lower sections are of $\frac{1}{4}$ -inch steel, and the upper two of $\frac{3}{8}$ -inch. As far as the rigidity of the bins is concerned, $\frac{3}{8}$ -in. steel would have been sufficient for all four courses, but $\frac{1}{4}$ -in. was used on the lower two so as to withstand abrasion from the coarse ore. These bins have proved satisfactory, especially to

the mill-men, who are relieved of all ore-bin shoveling. The ore is drawn out through two standard 18 by 24-in. steel-plate rack-and-pinion ore-bin gates passing over two 20 by 45-in. grizzlies spaced $1\frac{1}{2}$ inches and set on a 45° slope. The fine passes to the bucket-elevator and the coarse is fed to a No. 5 Superior McCully gyratory crusher set to $1\frac{1}{2}$ inch. The crushed product is elevated in the 14-in. belt-and-bucket elevator to a 9-ft. by 30-in. trommel, constructed of No. 10 wire, 2 mesh, having $\frac{3}{4}$ -in. openings and making 20 r.p.m. The wear on these screens is heavy, the life of each being only about two months. The oversize passes to a set of $37\frac{1}{2}$ by 15-in. Garfield rolls, and the undersize to the mill conveyor-belt. The rolls are set to $\frac{3}{4}$ -in. and readily handle the tough ore as well as an occasional drill-steel. Automatic feeding devices are not used, but in spite of the comparatively coarse feed, the roll-shells have not corrugated to any appreciable extent after seven months' run. The shells are of chrome-steel. The discharge from the rolls is returned by the elevator to the trommel for re-sizing. The trommel, elevator, and chutes are enclosed in a light, removable, dust-proof housing lined with sheet-iron. The conveyor is troughed and equipped with 14-in. Maxeon belt. It is 70.5 ft. centre to centre of

pulleys, inclined at an angle of 18° , and running at a speed of 300 ft. per minute.

The crusher, rolls, trommel, and elevator are driven by a 60-hp. Westinghouse induction-motor. This motor, as well as all others in the mill, is equipped with automatic overload-relay and no-voltage release. Goodrich Pinnacle rubber belting is used for driving the rolls and crusher and is giving good service. The belt-conveyor discharges the ore into a 15 by 28 ft. 100-ton steel bin, similar in construction to those in the crusher plant. Head grab-samples are taken from the ascending stream of ore. These have checked fairly well with smelter-returns, but an automatic dip-sampler will soon be installed.

The grinding department in the Packard mill differs radically from standard practice by the introduction of stage-grinding in short tube-mills. The grinding is done in two short-length Power & Mining Machinery Co. tube-mills in closed circuit with a Dorr duplex classifier. The designer of the mill is an advocate of short-length tube-mills, and the work they do has borne out his contentions regarding their efficiency. In spite of the presence of some soft ore, there is enough of the extremely tough silicified rhyolite to give a run-of-mine ore similar



THIS PICTURE IS FULL OF INTEREST TO THE METALLURGICAL ENGINEER, SHOWING MOTOR AND CHAIN-DRIVEN SHORT TUBE MILLS IN CLOSED-CIRCUIT WITH A CLASSIFIER.

to that of the average Californian Mother Lode mine.

Through a bin-gate the ore is drawn onto a 2 by 6-ft. Link-Belt steel apron-feeder, and discharged into the No. 1 tube-mill feed-box. This is, I believe, the first time that an apron-feeder has been used for this purpose in a cyanide plant. It has proved a thorough success. The regularity of the feed and the ease with which it can be adjusted are attractive features of the apron-feeder. The quantity of material fed to the tubes is regulated either by the speed of the feeder, controlled by an adjustable eccentric or by the amount that the ore-bin gate is opened. When once set, it needs no further attention.

In No. 1 tube-mill box the ore first comes in contact with the cyanide solution. Sufficient solution from the stock-tank is added to bring the moisture content up to 40%. The first tube-mill is six feet in diameter by five feet in length. At the discharge end, sufficient stock-solution for proper classification is added; and the pulp flows by gravity to the feed-box of the classifier. This machine does its usual excellent work. The classifier-discharge is transferred to the second tube-mill, 6 ft. diam. by 10 ft. long, by a 10 ft. by 8 in. screw-conveyor, chain-driven from the classifier-shaft. Solution is again added to bring the moisture up to 40%. The tube-mill discharge is again returned to the classifier.

No. 1 mill was designed for use as a ball-mill, but in the first test made with siliceous pebbles it did such satisfactory work that the change to a ball-mill will soon be made. It is probable that Campbell & Kelly liners and balls manufactured at Tonopah will be used. They have proved satisfactory in the Tonopah and Manhattan mills. Both mills are at present lined with Forbes white-iron liners. These are similar to the El Oro. They are spaced so as to allow for the removal of single sections when worn, thus obtaining maximum life for each liner. An average life of about eight months is indicated. The mills were started with siliceous pebble-loads, but selected rhyolite has largely replaced the Danish pebbles. Although the rhyolite is tough and silicified, it still retains enough of its granular structure to 'sand' somewhat, and it is evident that the capacity of the mills would be reduced below 90 tons daily if rhyolite entirely were used. However, as the rhyolite 'pebbles' contain sufficient gold and silver to pay for all handling, the use of them has proved economical, especially during the present scarcity and high price of the siliceous. No account is kept of the quantity added, as the amount about compensates for the moisture contained in the ore, no reduction for which is made in computing tonnage. The discharge-screens are 4 ft. diam., made in two sections. Being strongly ribbed on the discharge side, the ribs act as lifters assisting in a rapid discharge. The use of reverse-screw discharges was considered, but the reduction of discharge-area and capacity consequent upon their use would more than outweigh any advantage. The main bearings are 16 by 16 in. The scoop-feeds are of special design, having removable plates on the outer faces, allowing inspection of the spirals. They are also fitted with white iron digging lips, bolted to the frames, taking the heaviest

wear from the scoops. These lips last about six months and are easily and cheaply replaceable. The mills are driven by a single 100-hp. Westinghouse slip-ring induction motor. For this motor, a rheostatic controller is used. The motor is connected to the tube-mill gear-shaft by silent chain-drives and Hll clutches. These clutches are rarely used, the mills starting from rest on slow speed. The following screen-tests show the work being done in the grinding department.

		No. 1 tube-mill			No. 2 tube-mill		Classi- fier
	Screen aperture,	Head- ing	dis- charge	Classi- fier dis- charge	dis- charge	over- flow	
	Mesh	In.	%	%			
+	4	0.185	33.9	0.2	0.2	...	...
+	10	0.065	21.7	0.9	2.5	...	...
+	20	0.034	9.8	2.3	3.9	...	...
+	40	0.015	5.6	11.4	17.8	1.6	...
+	60	0.0087	2.9	10.4	22.8	11.8	0.4
+	100	0.0055	2.5	6.4	20.2	17.8	3.7
+	150	0.0041	2.7	6.9	12.9	16.2	6.8
+	200	0.0029	0.9	2.6	3.5	5.8	5.2
-	200	.....	19.6	57.8	15.9	46.2	83.3
			99.6	98.9	99.7	99.4	99.4

Of the minus 200 classifier-overflow product, 5.2% is sand and 94.8% slime. These screen-tests are not ex-

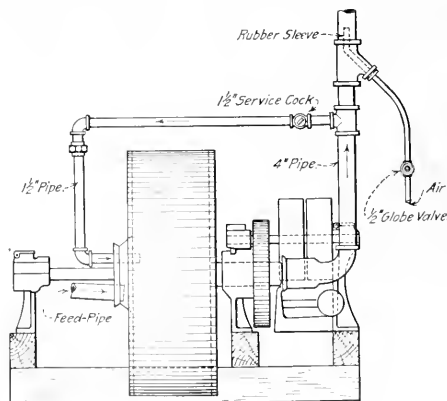


Fig. 3.

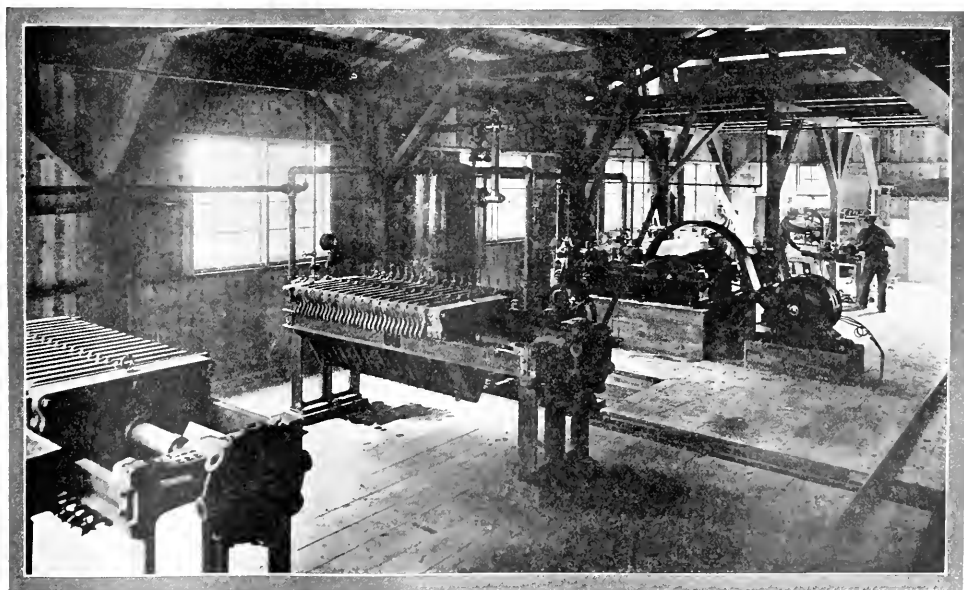
FRENIER PUMP ARRANGEMENT.

ceptional, but the averages of all tests made, the majority of them having been made while the pebble-load consisted of about 50% each of rhyolite and siliceous. A short while ago it was noted that a heavy concentrate was collecting in the feed and discharge boxes of the tube-mills and classifier; after removing the iron with a magnet, an assay of the residue showed \$2300 gold and \$180 silver per ton. An examination of the coarser particles proved the presence of flakes of a coated gold-silver alloy. As has been previously observed in many Mexican cyanide-plants where tube-mills were used, the fragments of copper and brass from caps, wire, etc., were heavily plated with silver. Careful tests on the tailing showed

that the classifier acted as an effective barrier to the passage of this concentrate farther into the mill-circuit.

The classifier-overflow, diluted to about 7:1, is elevated by a No. 1 Abbé-Frenier spiral pump to No. 1 Dorr thickener. The lift is about 23 ft., and as the maximum height to which a Frenier will elevate this material is about 20 ft., an air connection was made to the riser. Merely 'cracking' the valve admits enough air, acting on the air-lift principle, to overcome the difference. When first installed, the pump showed a disconcerting tendency to slop over under slight provocation. By returning a portion of the pulp through a by-pass as shown in the accompanying sketch, this trouble was entirely remedied. I believe that everyone who has seen the work done here by the Frenier will agree that it is far superior

ing-tank in which sixteen 5 by 8-ft. Butters-type canvas leaves are suspended. The clear solution is drawn through these leaves by a 2-in. Gould rotary pump, and discharged into a 12 by 10-ft. pregnant solution-tank. This clarified solution is pumped through one of two 16-frame 36-in. Merrill precipitation-presses by a 5½ by 6 Deane triplex-plunger pump. The two presses are used alternately, clean-ups being made every 12 to 15 days. Single cloths of No. 10 canvas only are used, safely withstanding a pressure of 35 lb., which is reached just before a clean-up. The same cloths are used several times. From 5 to 6 tons of solution per ton of ore is precipitated. The standard Merrill zinc-dust screw-feeder and emulsifier are used. The zinc is added to the pregnant solution at the pump intake, and is in contact



PRECIPITATION-PRESSES AND MOTOR-DRIVEN COMPRESSOR.

to the bucket-elevator or straight air-lift. However, when the manufacturer's catalogue naively states that "it is impossible to have the wheel elevate all the liquid without having some of the liquid overflow at times and when starting and stopping, so that it is absolutely necessary to provide a sump to receive the overflow," the prospective user may be pardoned for maintaining the Missourian attitude.

The Dorr classifier, Frenier apron-feeder and screw-conveyor, as well as the crushing-plant conveyor-belt, are driven by a 10-hp. motor. Discharge from the Frenier flows into a 28 by 10-ft. Dorr thickener (No. 1). So far, no trouble has been experienced from foaming in any part of the thickeners. They are all equipped with the simplified type of lifters, and with electric-bell overload-alarms. The solution overflows to a 12 by 10-ft. clarify-

ing-tank in which sixteen 5 by 8-ft. Butters-type canvas leaves are suspended. The clear solution is drawn through these leaves by a 2-in. Gould rotary pump, and discharged into a 12 by 10-ft. pregnant solution-tank. This clarified solution is pumped through one of two 16-frame 36-in. Merrill precipitation-presses by a 5½ by 6 Deane triplex-plunger pump. The two presses are used alternately, clean-ups being made every 12 to 15 days. Single cloths of No. 10 canvas only are used, safely withstanding a pressure of 35 lb., which is reached just before a clean-up. The same cloths are used several times. From 5 to 6 tons of solution per ton of ore is precipitated. The standard Merrill zinc-dust screw-feeder and emulsifier are used. The zinc is added to the pregnant solution at the pump intake, and is in contact

*Wherever assay-values are given in this article, they will be on the basis of 50-cent silver.

The pregnant solution entering the presses averages 1.6 KCN and 0.8 P. A. The effluent titrates 1.95 KCN and 0.7 P. A. A re-generation of 0.35 lb. KCN per ton on a 2-lb. solution is remarkable, but it has been repeatedly checked by different operators. The advantages of zinc-dust over shaving, except in smaller mills, have been too frequently mentioned to warrant repetition. The survival of the obsolete zinc-boxes shows tortoise tendencies.

The precipitate is dried to less than 14% moisture and shipped to the smelter. A refinery will be erected soon. A representative, though incomplete, analysis of the product follows:

	%		%
Ag	69.9	Al ₂ O ₃ + Fe ₂ O ₃	0.89
Au	0.022	Insoluble:	
Zn	15.50	Al ₂ O ₃	
CaCO ₃	3.35	SiO ₂ , etc. 1.61 }	2.03
CaO	0.82	Cu	trace
Na ₂ CO ₃	0.80	Pb	none

Returning to the mill-circuit: The underflow from No. 1 thickener, having a specific gravity of about 1.45, is discharged into the first of two Dorr agitators, each 28 by 16 ft., where it is diluted to a gravity of 1.3, with stock solution. Most of the cyanide and lead acetate are added in this agitator, the remainder being dissolved in the stock-tank. The cyanide strength is kept around 2 lb. KCN and the protective alkalinity at 0.8 lb. CaO per ton. Sodium cyanide in the 'cyan-egg' form is used, but following general custom, the silver nitrate solution is standardized to KCN. An analysis of the solution showed the following constituents:

	%		%
K ₂ Zn(CN) ₄	0.15	CaO	0.038*
NaCN (free)	0.07	Al ₂ (SO ₄) ₃	0.069
NaAg(CN) ₂	0.009	K ₂ Fe(CN) ₆	trace
SiO ₂	0.004		

*By analysis, 0.05 by P. A. determination.

Total solids at 110° = 0.359%.

Total cyanogen = 2.06 lb. per ton in terms of KCN.

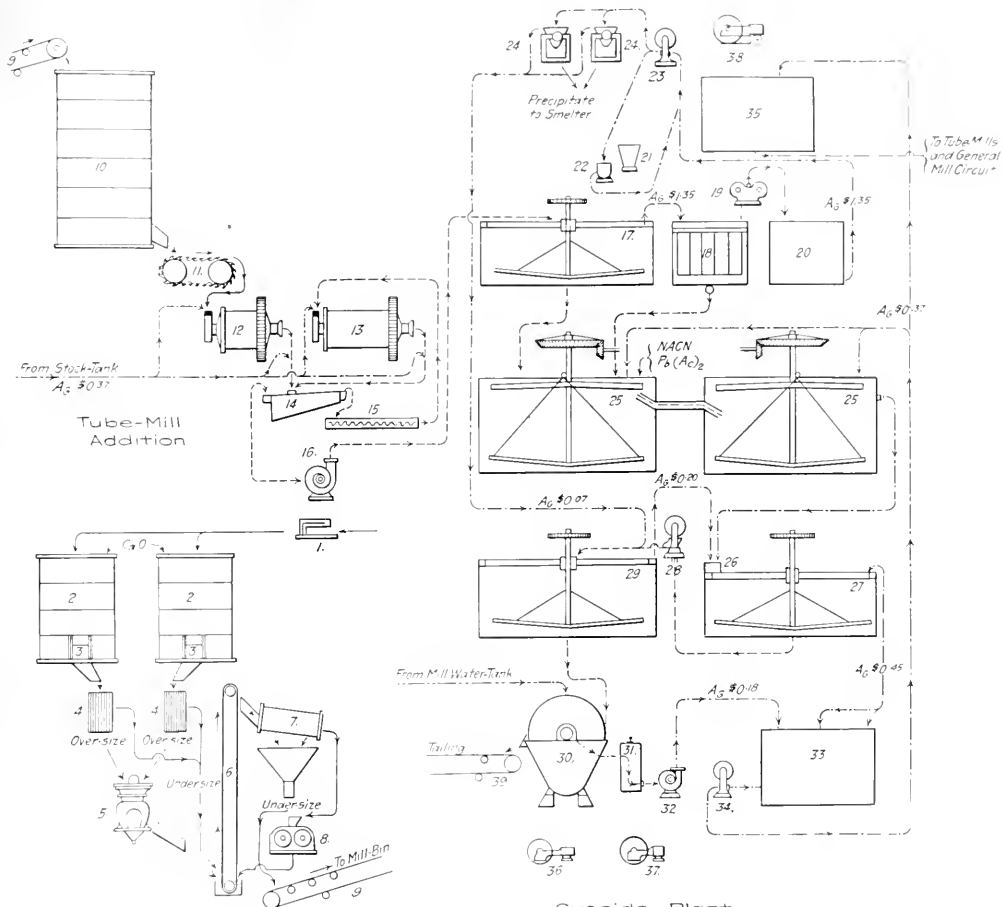
The reducing power of the solution is remarkably low, being equivalent to $\frac{1}{10}$ cc. N/10 KMnO₄ on a 10 cc. sample (with 2 cc. 1:1 H₂SO₄).

In the use of lead salts, we had the usual experience. Knowing that sulphides were practically absent, it was hoped that lead would not have to be used, though a supply was kept on hand. For the first three weeks the extraction remained near 95%, and then dropped gradually. Immediately upon the addition of lead acetate, the extraction returned to normal. Frequent tests with both nitro-prusside and lead carbonate have failed to show a trace of alkaline sulphides in any part of the mill-circuit. Ten pounds of lead acetate only are added daily.

The two agitators are connected in series by a straight pipe. The agitating mechanism is suspended from the roof-trusses. A unique feature is the use of one right and one left-hand drive. Besides the more symmetrical arrangement, there is a saving of one bent in the mill-framing. The air is—or was—admitted at the bottom of the tanks, through ball-check air-inlet valves. Soon

after beginning operations, one valve snapped off, and was found reposing in one of the launder-arms. The agitator worked as well as ever, so the valve was never replaced. The Dorr machines work well on low air-pressures, require practically no attention and little power. Although a development of the last few years, they have already sent many of the weird and wonderful devices that went by the name of agitators to the scrap-heap. The two agitators, thickener, zinc-dust feeder, triplex and rotary pumps are driven by a 10-hp. motor.

From the agitators the pulp flows by gravity to the feed-box of No. 2 Dorr thickener—the first of two counter-current decantation tanks. It is diluted in the box by the overflow from No. 3 thickener and flows down a staggered riffle mixing-launder to the feed-well of No. 2 thickener. The clear solution flows to the sump-tank. The discharge is transferred by a No. 4 Colorado Iron Works diaphragm pump to No. 3 thickener, where it is diluted with the barren solution discharged from the Merrill presses. No. 2 thickener is 28 ft. diam. by 1 ft. deep. No. 3 thickener has the same diameter but is 12 ft. deep, giving a fall of two feet between them for allowing the decanted solution to flow from the third to the second tank. The increase in the depth of this tank provides additional storage-room for pulp during shut-downs of the filter. The underflow, having a specific gravity of about 1.5, is discharged into an 11½ by 12-ft. Oliver filter. The vacuum is maintained at 22 in. by a 10 by 12 in. Doak dry-vacuum pump connected with a receiver fitted with the usual float-valve release. The pipe connecting the receiver and dry-vacuum pump is run to the upper mill-floor and back, giving an effective rise of nearly 50 ft. It is not always remembered in installing dry-vacuum pumps for filtration that the combined air-lift action and vacuum will raise the solution many feet above the theoretical 30, if the float valve fails to release. The solution is handled by a 2-in. Krogh centrifugal pump, discharging into the 20 by 12 ft. sump-tank. External air-lifts as well as mechanical agitators are used to keep the pulp from settling. The filter-canvas will have a probable life of 10 months. Water only is used for washing and is sprayed on both the ascending and descending sides by vermord sprays. It is interesting to note that giving the cake practically the limit of water-wash just holds the amount of solution constant in the mill-circuit. In many of the Californian mills, an all-water wash would make the 'wasting' of solution necessary in a very short time. The explanation of the difference lies, of course, in the low moisture-content of the ore treated and the excessive evaporation of mill-solution due to the dry atmosphere. The cake is discharged with a moisture-content of 21.4%. Daily determinations of the soluble loss were made for the period of one month, and averaged slightly over 5 cents per ton. This low loss is due to the reduction in value of the solution by counter-current wash in the thickeners and the heavy water-wash on the drum. All soluble-loss assays are made by determining the moisture-content of the sample, agitating thoroughly with a measured volume of water



Crushing Plant.

Cyanide Plant

- 1 Fairbanks Recording Reams Scale
- 2 12' x 16' Steel Ore Bin
- 3 18' x 24' 5" x 1" Roll Gates
- 4 20' x 45' Grizzlies, 18" Spacing
- 5 NPS McCall's Rotary Crusher, Superior Type
- 6 14' Belt and Bucket Elevator, 10' x 6' Mill Buckets
- 7 30' x 9' 3" Tumbler, 2 mesh, N°10 Wire Screen
- 8 15 1/2' x 37' x 1/2" Field Rolls
- 9 14' Conveyor Belt
- 10 15' x 26' Steel Ore Bin
- 11 2' x 6' Steel Apron Feeder
- 12 5' x 6' Tube-Mill
- 13 6' x 3' Tube-Mill
- 14 Dorr Duplex Classifier
- 15 8' x 12' Screw Classifier
- 16 NPS Turner Pump
- 17 10' x 12' Dorr Thickener
- 18 10' x 12' Clarifying Tank, 10' x 3' Butters Leaves
- 19 2" Rotary Force Pump, 11" Dia.
- 20 10' x 11' Primary Solution Tank
- 21 Merrill 12" No. 2 Feeders
- 22 Zinc Dust Emulsifier
- 23 5 1/2' x 12' Deane Triplex Pump
- 24 36" Merrill Precipitating Presses, 10 Frame

- Dry Ore —————
Pulp —————
Solution —————
Water —————

- 25 6' x 28' Dorr Agitators
- 26 Feed Box
- 27 10' x 28' Dorr Thickener
- 28 NPS Diaphragm Pump, Colorado Iron Works Type
- 29 12' x 28' Dorr Thickener
- 30 12' x 12' Oliver Filter
- 31 Vacuum Receiver
- 32 Kragg Centrifugal Pump
- 33 12' x 20' Pump Tank
- 34 12' x 6' Deane Triplex Pump
- 35 12' x 18' Deane Tank
- 36 4' x 12' Dry Vacuum Pump
- 37 12' x 18' Ingersoll Rand Air Compressor, 100 P.S.I.
- 38 12' x 18' Ingersoll Rand Air Compressor, 100 P.S.I.
- 39 12' Belt Conveyor

and assaying the filtered solution. It need scarcely be remarked that the unwashed-minus-washed tailing method does not give accurate results. The cyanide loss in the tailing is under 0.2 lb. per ton. It is a safe prediction that the counter-current decantation method is going to play a large part in future cyanidation. It is an equally safe prediction, however, that except in the case of low-grade ore treated with low-content cyanide solutions, continuous vacuum-filtration will follow the decantation step in the process.

The following table gives the extraction throughout the mill:

	Assay-value	Cumulative extraction, %
Headings	\$7.06	...
Washed No. 1 tube-mill discharge	3.16	55.3
Washed classifier-discharge	3.31	53.1
Washed No. 2 tube-mill discharge	2.07	70.0
Washed classifier overflow	1.45	79.5
Washed No. 1 thickener discharge	1.38	80.4
Washed No. 2 agitator discharge	0.56	92.1
Washed No. 2 thickener discharge	0.49	93.0
Washed No. 3 thickener discharge (filter-feed)	0.46	93.5
Washed filter-tailing	0.28	94.6
Unwashed filter-tailing	0.44	93.8

The above are the averages of a number of assays run on consecutive days. The high extraction in the tube-mill circuit and the low extraction in the thickeners are interesting. The tailing is conveyed to the dump by a 12-in. Goodrich conveyor-belt, only sufficient water being added to keep the discharge-chute wet. A 5-hp. motor direct-g geared to the head pulley drives the tailing-conveyor. A 30-hp. motor furnishes power for driving the two lower thickeners, diaphragm-pump, Oliver filter, transfer-pump, air-compressor, and Deane triplex pump. The latter, equipped with the usual by-pass, returns the solution from the sump-tank to the stock-tank at the head of the mill.

The power-line of the Nevada Valleys Power Co. delivers the current to the transformers at 6600 volts, and is there stepped down to 440 volts for the motors, and to 120 volts for the lighting circuit. 250-watt nitrogen lamps are used for illuminating the tube-mill floor, and 60-watt tungsten-filament lamps elsewhere. In order to balance the power-load, the crusher and rolls are run on graveyard shift while the compressor at the mine is shut-down.

The entire crew in the mill consists of three solution-men, three solution-helpers, a repair-man and a roustabout. The solution-helpers run the crusher. As the mine-compressor is in the mill-building, and is looked after by the mill-crew, the time of one man daily is charged to mine-account. The wages paid are probably as high as any in Nevada.

Solution-men	\$5.00	Roustabout	\$4.00
Solution-helpers	1.50	Repair-man	5.00

The cost per ton milled, on a basis of 2736 tons per month (the average since starting) is \$1.265 per ton distributed as follows:

	Consumption per ton of ore milled, Lb.	Price per lb., Cents	Cost per ton, Cents	%
Cyanide	0.316	25	7.9	6.3
Lead acetate	0.118	13.7	1.7	1.4
Zinc	0.747	29	21.8	17.2
Pebbles (exclusive of mine-rock)	2.29	7.5	4.0	3.1
Hydrochloric acid	0.029	7.5	0.2	0.1
Lime	2.36	1.1	2.6	2.1
Power, 1,425 hp. at 26.5c. per hp.-day			38.0	29.9
Assaying (73% labor)			3.3	2.8
Miscellaneous chemicals			0.2	0.1
Labor			31.5	24.9
Supervision			2.9	2.3
Maintenance and repairs (90% labor)			3.9	3.0
Miscellaneous supplies			8.5	6.7
Total			\$1.265	100.0

The extraction, based on smelter-returns, has averaged 94.9% since the beginning of operations.

In conclusion, a few words may be added regarding what Gelasio Cactani has called "the psychology of milling." The mill is well lighted and arranged so that all parts are easily accessible. The company furnishes the unmarried men on shift-work with cabins, while the bunkhouses of the miners are divided into rooms, two men sharing a room. The boarding-house is run at cost, and high wages are paid. A total mining, milling, and development cost of a few cents over \$4 per ton, and an extraction of 95% of the precious metals in the ore strengthens the belief of the management that successful mining and low wages are not synonymous.

I am indebted to Mr. Freitag for many of the data given in this article, and also to J. W. Wilkey, superintendent, and B. B. Hall, accountant, of the Nevada Packard Mines Co. for aid given in its preparation.

THE TURN in the zinc market as a consequence of War conditions is indicated by the record of the Consolidated Interstate-Callahan mine in the Coeur d'Alene. Previous to the War, the company was losing money. For the year ended June 30, 1914, the operating loss was \$99,314. During the year ended June 30, 1915, this debt was paid, dividends of \$697,597 were distributed, and in addition there remained a surplus of \$1,094,862. A single dividend in August, 1915, was \$960,000, and the dividends during 1915 totaled \$2,530,000. During the first six months of 1916, the Interstate-Callahan paid dividends of \$1,394,970.

A TIN-CONCENTRATING AND SMELTING PLANT for the An-Yuan mines in Hunan province, southern China, is shortly to be placed in commission by the Wah Chang Mining & Smelting Co., which will offer this product for sale at New York and through agencies in Europe. These mines are in the Ichanghsien district, and contain both oxide and sulphide ores occurring as chimneys in limestone, marmorized by granite and intruded by a later granite dike along the course of which the ore-chimneys are found.

Mining and Milling in Arkansas

By L. L. Wittich

*Zinc and lead ores shipped from northern Arkansas mines aggregate 80 to 100 carloads per month. About 85% of this is zinc carbonate, 5% sphalerite and 5% lead, chiefly galena. At no time has the output been so heavy; at no time has activity in mill construction been so pronounced. The influx to Arkansas fields is due to the high price of zinc ore, and the steady development of the mining industry is resulting in new mining centres springing up at several points, while old ones are becoming greatly overcrowded.

Unlike the deposits of the Joplin district (Missouri-Kansas-Oklahoma), which are found in the Mississippian series of the carboniferous system, the Arkansas ores occur chiefly in the Yellville formation of the Ordovician system, which is a much older sedimentation than the Mississippian. Overlying the Ordovician and underlying the carboniferous is found the Devonian. The Yellville formation is composed of magnesian dolomites, outcrops being common in northern Arkansas. The base of this system shows no outcropping and its depth is estimated only by deep drilling, which indicates that it may extend down to the pre-Cambrian crystallines. Where the Yellville formation outcrops along the White river its width reaches 500 ft. Whereas the coollite limestone is the guiding geological formation of the Joplin district, overlying the Grand Falls chert or ore-bearing stratum of the sheetground regions, in the northern Arkansas field, the most valuable guide is the Key sandstone occurring in benches and usually marking the cap-rock, overlying the dolomites in which the ore occurs. Fracturing, jointing, faulting and slight brecciation characterize the areas where the mineral is most likely to be found. The ore, when a blende, usually produces a concentrate containing as high as 62 to 64% metallic zinc, with no iron, while the carbonates produce a concentrate or free chunk ore from 38 to 48% metal. The Key sandstone is distinguished through its resemblance to coarse brown sugar and its decomposed formation.

The first mining for lead was in 1818, but not until 1857 was this ore produced on an extensive scale. In the same year zinc carbonate was extracted for the first time. In 1899 prices soared to a point that encouraged extensive mill construction. The greatest activity, however, began about six months ago, since which time about 20 mills, chiefly of the most modern design, have been constructed, and 12 or 15 more are under course of erection or will be built in the near future.

As the ore-bearing stratum usually is found high on the mountain-side, the method of mining is, in most instances, confined to adits on the orebody. Sometimes the

ore formation is simply quarried, and where it is rich enough, mill concentration is sometimes dispensed with and the free carbonate (little blende is mined in this manner) is corded up and sold to the smelter. The ore is sold chiefly in the open market to the highest bidder, although where some producers have made long-time contracts with smelting concerns, the producers are getting all the best of it, due to the fact that the open-market prices have declined materially, whereas the contract settlement is holding firm. The ore goes to smelters in Illinois, Kansas, and Oklahoma, and is reputed to make an exception-



MAP OF ARKANSAS ZINC DISTRICT. SMELTERS ARE AT FORT SMITH AND VAN BUREN.

ally choice grade of spelter, due to the almost complete absence of lead and to the high grade of the metallic content.

The big Hurricane No. 2 mill, operated by John Conness Shepherd of Rush, situated four miles west of Pindall, Arkansas, or 40 miles west of Rush, will be one of the most complete plants in the district. It will be equipped with a 6-ft. by 16-in. Hardinge conical mill, the first of the kind to be used either in the Missouri or the Arkansas district. Shepherd owns the fee to 588 acres on which the Hurricane is situated, having purchased it recently for \$85,000.

Over the Hurricane No. 1, which is a mere 'coffee mill,' the output is 25 to 40 tons of concentrate per week. A carbonate deposit, outcropping on a hill-side, and mined from an open-pit, which now has reached a depth of 85 ft., and a length of 200 ft., supplies the ore. The No. 2 mill will be situated across the valley north from No. 1, and will, for the time, handle only the tailing from the No. 1 property. The new mill will be equipped with a Dorr thickener, 30 ft. diam. by 10 ft. deep, seven Wilfley

*Abstract from Joplin, Missouri, *News Herald*, written shortly before the writer's death in June.

tables, and one Deister-Overstrom slime-table. Feed for the mill will be supplied with a 3-in. pump. The mill will be driven by a Fairbanks-Morse oil-engine.

At the Philadelphia mine (on Clabber creek, at Rush), steam power has been replaced with oil-engines of the Fairbanks-Morse make, one of 100 hp. to run the mill machinery, and another of similar capacity to operate a 600-ft. Ingersoll-Rand compressor. Sullivan jack-hammers are to be used for the lighter work of putting in prospect drifts, while the regulation drills will continue in use driving adits. A new aerial tram $\frac{1}{2}$ -mile long, spanning a deep ravine, will connect the Monticello shaft on the south side of the valley with the mill. The tram will be almost 200 ft. high at its highest point, and will cost \$8000. Mining at the Philadelphia, which is one of the steadiest producers in the Rush field, is carried on from three adits at various elevations above the bottom of the valley. The highest is about 225 ft. above the creek-bed. Beneath this is another 175 ft. above the creek-level. Some workings rise above the floor of the main adit, others below, according to the trend of the orebody, which has 'made' in 'breaks' between limestone walls. The ore from both these adits is sent down chutes, lined with railroad iron, to the mill hopper. From the third adit, which is only 30 ft. above the creek-bed, the ore is hauled to the mill, and hoisted to the hopper. In addition to the two Wilfley tables that have been in use at this property, two additional ones are being installed.

Two large new concentrating plants have just been completed in the south end of the town of New Rush, which is $1\frac{1}{4}$ miles down Rush creek from the old town. These mills are the Edith and the Yellow Rose, the former operated by E. Emanuel and the latter by James McCarty & Co. The Edith gets its ore, a white carbonate, from an adit in the mountain-side, and treats it in a 200-ton plant operated by two 50-hp. Chicago-Pneumatic oil-engines. The mine is situated on a lease from the Buffalo Zinc & Copper Co. The Yellow Rose is equipped with Chicago-Pneumatic oil-engines and has a capacity of 100 tons. The company owns a fee to four acres and has first lease on 40 additional acres.

Although conditions are ideal for gravity milling, the system is little in use throughout the Arkansas mines, and the treatment is much the same as in the average plant where ore is hoisted from a vertical shaft. The one important exception to the rule is the McIntosh mill, a new plant of 100 tons' capacity, situated on an 80-acre lease between the new and the old towns of Rush, and owned by J. C. Shepherd. Steam power, wood being the fuel used, drives the mill. The ore passes from hopper to crusher, then to rolls and revolving screen, thence through the ordinary process of mill concentration, each step, however, being at a lower level than the preceding one. Only one elevator is used, that being to lift the middling back to the rolls.

LEAD EXPORTS from Bolivia during the first four months of 1916 amounted to 1,818,000 lb. In the whole of 1915 the total was 4,855,400 lb., and 3,421,000 lb. in 1914.

Tungsten Near Bishop, California

By Leroy A. Palmer

The new mill of the Tungsten Mines Co. is 8 miles from Bishop. It is the largest tungsten mill in the country, and is expected to be in operation by the latter part of August. The initial capacity is 350 tons per day of scheelite ore.

The mine has been opened by three levels, which give a depth of 215 ft. on the vein. The ore is trammed around the mountain, a distance of 1800 ft., and dumped into the crude-ore bin at the mill. From this a short conveyor carries it to a 500-ton Wall crusher, which reduces to $1\frac{1}{2}$ in. This product goes to a 4-mesh trommel, the oversize of which goes to a bin, the undersize to two sets of rolls, 14 by 20 in. and 16 by 26 in. The oversize is fed from the bin by means of a conveyor to a set of 15 by 40-in. Allis-Chalmers Anaconda type rolls. This product goes to two 4-mesh trommels, the oversize being elevated to two sets of Allis-Chalmers rolls for further grinding. The undersize joins that of the first 4-mesh trommel and is reduced finer in the two sets of rolls mentioned, 14 by 20 in. and 16 by 26 in. These rolls discharge to two 14-mesh trommels, whose undersize goes to an Akins classifier and oversize to the elevator to the two sets of Allis-Chalmers rolls. The product of the latter is separated in a similar pair of 14-mesh trommels, oversize to the elevator and undersize to the classifier. The coarser sand from the classifier is treated on five Isbell tables and the finer sand on four Wilfleys. Slime from the classifier is settled in three 6-ft. Callow tanks and treated on two Deister slime-tables.

Power is obtained from the Nevada-California Power Co., whose lines pass close to the plant. Individual motors totaling 130 hp. are used.

THE ATTITUDE of neutral countries toward gold imports is curious and interesting. It is reported that Holland wished to purchase lumber from Sweden, and as Sweden would not take any gold, such purchase was found to be impracticable, as the two countries possessed more gold than they needed or cared to have. After prolonged negotiations, Sweden agreed to take a certain amount of gold, as a matter of grace, at a price 3% lower than the ruling rate. The transaction was then completed and Holland received its lumber. Thus the extraordinary circumstances occurred of gold being accepted by a State institution only at a heavy discount compared with the currency of that country. The National City Bank of New York remarks in an interesting circular that the Norwegian kroner on April 22 had the proud position of having the monetary values of the entire globe under par with respect to its own value.—Weekly letter of Samuel Montagu & Co., London.

SAND AND GRAVEL production of the United States in 1915 was 76,603,303 tons, valued at \$23,121,617.

Zinc Smelting in Vertical Retorts

*It has been known during the last half-dozen years that experiments were being conducted in Germany with the object of evolving a continuous zinc-smelting process using vertical retorts. The great advantage of such a process would be the reduction of the amount of skilled labor required and the improvement in the nature and conditions of the labor, together with other economic considerations. M. Liebig read a paper before the German Metallurgical and Mining Society in 1913 describing the process and plant devised on this system by Roitzheim

the usual type, the former let into the walls of the retort horizontally, the outer ends being supported by the wall of the furnace. The condensed zinc and zinc-dust are collected in the usual way, but as the condensers of a row of retorts are all on one level, the collection is much easier than is the case with the ordinary furnace having tiers of horizontal retorts. The charging and discharging are both done mechanically. The charging is done from cars traveling over the furnace, and the discharged ash is carried away by conveyors or cars. It will be seen

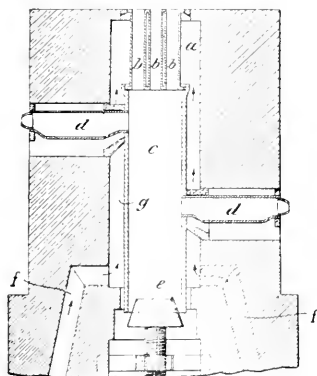


FIG. 1. PRELIMINARY HEATING DEVICE.

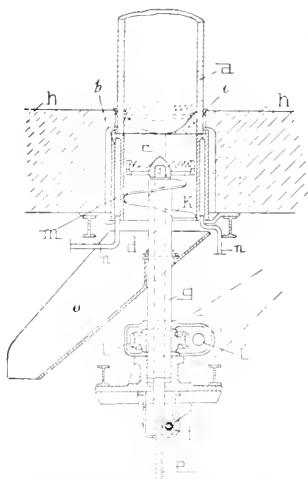


FIG. 2. SCRAPER FOR KEEPING BOTTOM OF RETORT CLEAR.

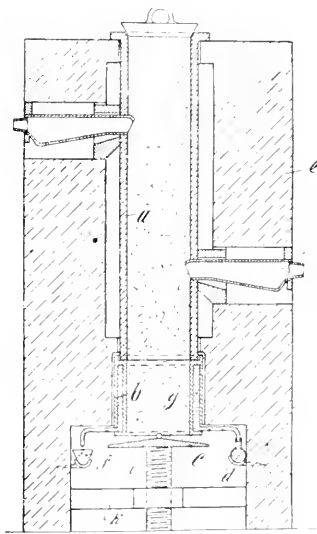


FIG. 3. COOLING DEVICE FOR DISCHARGE-END.

and Remy. He has more recently described the perfected plant, erected under these patents at the Hamborn zinc smelter of the Aktiengesellschaft für Zink Industrie formerly Wilhelm Grillo, the article appearing in *Metall and Erz* for March 22 last. The description of the process given in the following paragraphs is based partly on this article and partly on British Patents 1338 of 1912 and 732, 6771, and 9314 of 1913. The illustrations are taken from the patent specifications.

It will be seen, by reference to the drawings, that the retorts are mounted vertically in the furnaces. They are fed at the top through special openings, where the charge is given a preliminary heat, itself forming a seal to the rest of the retort. The ash is discharged from the bottom by means of a convenient mechanical appliance. The condensers and prolongs (otherwise nozzles) are of

that the conditions of labor are much easier than with the ordinary furnace. The difficult process of charging the horizontal retorts by hand is entirely abolished, as also is the objectionable duty of removing the residue from the hot retort. It is estimated that the labor force will be halved, and that for most of the work only unskilled labor will be required. The prolongs, as in the case of the modern German practice, are divided down the middle, and the carbonic oxide and other gases evolved during smelting are not discharged into the air but sent to the stack and burnt. The retorts are arranged in two rows back to back, with a central brick chequer-work between, and in a full-sized furnace there would be 40 retorts, 20 in each row. The life of the retorts is much longer than that of the horizontal retorts, as the temperature is uniform, and there is no rough usage in charging and discharging. As the process is continuous, the capacity of the retort is much greater.

*Précis by Edward Walker, in *The Mining Magazine*, July 1916.

In looking through the British Patent specifications mentioned above, it is clear that the application to zinc smelting of the continuous vertical retort or muffle heated from the outside is not patentable, and that the Roitzheim and Remy patents relate to methods of overcoming difficulties in practice. It will be seen also that the retorts illustrated have two condensers, one on each side; whereas in the description by Liebig mention is only made of one condenser.

In Fig. 1 is reproduced the drawing attached to patent 1338 of 1902. The object of the invention therein described is to provide a preliminary heater for the charge, the heating being effected without any reduction of the zinc. The preliminary heater or fitting *a* is formed with a number of small tubes or narrow passages *b*, through which the charge passes. These are surrounded by the flames within an extension of the furnace. The large contact surfaces and narrow cross-sections of the tubes enable the mixture to be quickly and completely heated. From the preliminary heater the material descends into the retort *c* below. The condensers are shown at *d*. The residue is continuously or at short intervals removed at *e*. The mixed materials sink gradually in the retort. The hot gases for heating the retort ascend from the ports *f* along the annular space *g* and then escape through an opening near the top of the furnace.

Patent 732 of 1913 (Fig. 2) relates to a method of keeping the discharge-end of the retort clear of obstruction. In practice it is found that the residue hardens on the walls of the retorts, where they project out of the furnace. At the lower mouth of the retort a rim of slag is formed which would constrict the opening and finally entirely close it if arrangements were not made for its removal. The invention consists of means for cutting away or removing these crusts. The retort *a* is preferably of circular section at its lower mouth, and it is mounted on the support *b*. A rotatable cutter *c*, such as a milling-cutter, or a borer or scraping tool, is mounted on the square shaft *d*. The lower end of this shaft carries a toothed rack, shown at *e*. A pinion *f*, which is rotated by means of a crank handle, meshes with the teeth of the rack, so that the shaft *d* can be elevated and lowered by it. The shaft *d* is held as in a guide by the spindle *g*. This spindle carries the worm *k*. The quantity of charge traveling through the furnace can be regulated by varying the speed and pitch of the worm. The spindle *g* is driven by worm-gears *l*, *l'*. The support *b* is provided with a cooling device, comprising the chamber *m* and the water-supply and discharge-pipes *n*. A chute *o* is also provided.

Patent 6771 of 1913 (Fig. 3) concerns a method of cooling the lower part of the retort, so that the discharged residue shall not contain vapor. If the residue is discharged hot, vapors of lead, zinc, and sulphur are given off, greatly to the discomfort of the workers. The illustration shows vertical retort *a* in a furnace *c*. A jacketed vessel *b*, made of a suitable metal, is fixed at the bottom. Between its double walls a current of water or steam flows, so that effective cooling is obtained. The

vessel is held tightly against the lower edge of the retort, so that it may be considered to form an extension of the retort. It is closed below by a grate, or as shown in the drawing by the residue heaped on the conical plate *c*. This plate *c* is secured to a screw *i*, which screws in the stationary plate *k*, whereby the said conical plate *c* can be raised or lowered. The pipe *d* supplies the cooling water, which flows through the jacket space *g* between the walls of the vessel *b* and runs out through suitable outlet-pipes into a discharge or gutter *f*.

Patent 9314 of 1913 describes internal arrangements within the retorts for facilitating the escape of the gases and vapors and need not be quoted at length.

In examining the illustrations it is well to remember that they are merely sketches and not necessarily working drawings; also that the descriptions in the patent specifications do not necessarily represent the actual practice. In several ways the descriptions in Liebig's article do not tally with those of the specification, notably in the number of condensers used.

The Chilean Nitrate Situation

For the 11 months ended May 31, 1916, the production of Chilean saltpeter was 67% greater than for the corresponding period of the preceding nitrate year. In this fact lies one of the chief explanations of the improvement in the value of the Chilean paper peso and also in the purchasing power of the country. No one knows what the effect of peace is going to be on the nitrate industry, and it would seem reasonable that when the use of explosives ceases there might be immediate stoppage in orders for nitrate, unless the War ended at the period when nitrate is needed as a fertilizer.

One of the surprising features of the nitrate industry, at least to a casual observer, has been that, in spite of the great demand and the high prices obtained abroad, the price of nitrate in Chile has not risen much above the normal figure of previous years. This is undoubtedly due to the fact that when the sudden stoppage of shipments occurred and many men were thrown out of employment in the nitrate fields, thereby making it impossible for them to buy the agricultural products of the south, the Government advanced large sums of money to the producers solely for the purpose of keeping their plants running. They, of course, piled up an enormous supply, which, coupled with a general resumption of work, meant that there was always more nitrate available than ships to carry it. The difference between the price received for nitrate in Chile and that paid by purchasers in foreign countries has been absorbed in ocean-freight rates. Exchange was down when there were no ships to transport the nitrate. Cargo space is a little more plentiful now, and vast quantities of saltpeter are being sold. Gold is coming in, and, being abundant, it becomes cheap; or, to put it another way, one buys dollars with fewer pesos than when gold was dear.—*Commerce Report*.

Frue vanner (21) passed to the tailing-elevator (22). The overflow from the Callow tank (15), together with the tailing of the smooth vanner (25), joined the water from (23) at the centrifugal pump (24) and was elevated to the Callow tanks (16) (17) and (18), which fed the three A. & E. slime-tables (26).

A screen test on the ore after being ground in the Elspass mill showed:

Mesh	%	Mesh	%
On 20.....	10.49	On 150.....	8.34
" 40.....	17.29	" 200.....	4.79
" 60.....	10.49	Through 200.....	39.39
" 100.....	8.19		

This test indicates that the Elspass mill slimes the ore too much for high recovery by concentration. A large proportion of that passing the 200-mesh screen

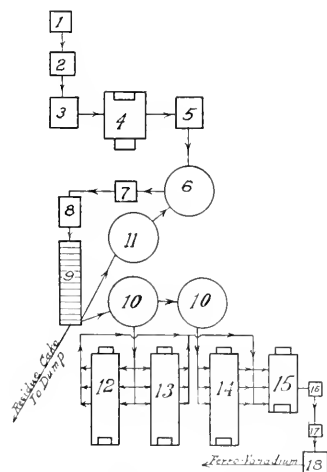


FIG. 3. VANADIUM OXIDE PLANT No. 1.

was lost, as will be seen in the following test on the tailing.

Mesh	%	Assay, % V
On 100.....	30.26	0.0675
" 150.....	24.80	0.0666
" 200.....	9.52	0.0625
Through 200.....	35.42	0.1700

A series of 19 mill-runs was made on lots ranging from 9490 to 21,000 lb. of mill-tailing assaying from 0.1721 to 0.24% vanadium.

To illustrate how some of these tests were made, I submit the flow-sheet No. 2 and the following description:

Mill-tailing treated for further recovery was weighed on the Buffalo track-scales (1), passed through the grizzly (2) into the ore-bin (4), then through rolls (6) and (7) onto the impact screen (8), where the over-size was elevated by a centrifugal pump (9) back to the rolls (7) and the under-size delivered into the Isbell classifier (10), whose spigot discharged onto the Wilfley table (12). The middling from Wilfley table (12) was treated on Wilfley table (20) and the tailing from Wil-

fley table (12), together with the tailing from Wilfley table (20), were sent to the tailing-elevator (18). The middling from Wilfley (20) passed to the corrugated Frue vanner (14). The overflow from the Isbell classifier (10) entered the two-compartment classifier (11) whose spigots discharged onto the two Wilfley tables (13), and the overflow from classifier (11) entered the 6-ft. Callow tank (23) whose spigot discharged onto the smooth Frue vanner (15).

The tailing from the Wilfley tables (13) and the corrugated Frue vanner (14) were sent to the elevator (18), and the middlings from the Wilfley tables (13) were sent to the corrugated Frue vanner (14). The overflow from the 6-ft. Callow tank (23) and the tailing from the smooth Frue vanner (15) were discharged into the 6-ft. Callow tank (19), whose spigot fed the A. & E. slime-table (17).

A set of 16 by 36-inch Colorado Iron Works rolls was substituted for the Elspass mill during the last half of the tests. The tailings were ground to sizes varying from 20 to 80-mesh by these rolls, and an average extraction of 55.35% of the vanadium was obtained. Figures based on these tests indicate an extraction of vanadium not less than 80 to 86%, when treating the ore in the order outlined below.

(1) Crushing with rolls.

(2) Screening.

(3) Concentration.

(4) Re-grinding the tailings and middlings from the Wilfley tables, the tailing from the corrugated Frue vanner, and the over-size from the impact screens of the re-grinding unit, in a Hardinge conical mill.

(5) Screening.

(6) Classification.

(7) Concentration of the re-ground product, and

(8) Concentration of slimes from both primary and secondary crushings.

SMELTING. The treatment of high-grade ore from the mine and of concentrate and slime from the mill by acid-leaching methods is expensive. The insoluble sulphates of barium, calcium, and lead, in the sludge, prevent the recovery of the lead. The elimination of the copper, arsenic, and phosphorus from the vanadium solutions makes the process tedious, complicated, and expensive.

After much experimentation, vanadium ore, concentrate or slime, commercial sodium carbonate, and coal were charged into a furnace and smelted. This yielded metallic lead and a vanadium slag practically free from copper, arsenic, and phosphorus. The results from test No. 35, following, illustrates the method:

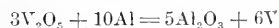
	%
Ore assayed, vanadium	3.60
Ore assayed, lead	23.54
Weight of ore exceeds weight of slag per charge.....	32.66
Lead recovered	90.50
Slag assayed, vanadium	5.22
Slag should have assayed, vanadium	5.35
Extraction of vanadium from slag	98.50
Value of lead recovered per ton of ore smelted.....	\$21.19
Cost of flux per ton of ore smelted.....	\$4.56

LEACHING. Pulverize the slag in the crushing unit (1), as shown on flow-sheet No. 3, weigh the quantities on the scales (2), in (3) stir concentrated commercial sulphuric acid into the ground slag until the mass is pasty and charge the mass into the baking-furnace (4). Bake to dry cake, pulverize in (5), lixiviate with water and boil for several hours in the steam-coil-heated, circular, wooden, lead-lined, lixiviating vat (6). During the

waters are used to lixiviate fresh lots of pulverized dry cake in vat (6).

The vanadium liquors from storage-tanks (10) are drawn into evaporating-furnaces (12), (13), and (14), where the water and free sulphuric acid are driven off. The solid material, principally vanadium sulphate, is calcined in the furnace (15) at a moderately high temperature to drive off the sulphur, which, in a semi-molten state, is prepared for the reduction department by granulating it in water (16).

REDUCTION. Mix the vanadium oxide, V_2O_5 , with granulated aluminum and iron filings or borings of low carbon and charge into a 220-lb. capacity hopper (17) in which the materials are mixed. At the bottom of the hopper a screw-conveyor feeds the mixture through an opening into a magnesite-lined crucible (18) large enough to hold the charge. Place a small amount of sodium peroxide on paper in the bottom of the crucible to start the chemical action between the vanadium, aluminum, and oxygen, thus:



The high temperature created during this reaction melts the iron borings with the vanadium, forming the alloy, ferro-vanadium. The aluminum oxide and other impurities of lighter specific gravity form a slag on top of the ferro-vanadium. After cooling, break the slag from the ferro-vanadium, with sledges. This ferro-vanadium (30.55% to 40% V, brittle when cold, after being crushed and sized, is the commercial product.



VANADIUM-OXIDE PLANT. CUTTER, NEW MEXICO.

baking of the cake the excess of the sulphuric acid can be recovered by passing the hot fume through water, making a saving in a 10-ton plant of about \$49 per day. Pump the charge through the acid egg (8) into the sulphate filter-press (9) at about 120-lb. pressure and collect the vanadium solution in the circular, wooden, lead-lined storage-tanks (10). Wash the sulphates in the filter-press (9) with water under a pressure of 120 to 150 lb. and collect the wash-water in the circular, wooden, lead-lined storage-tank (11). These wash-

Two Great Copper Mines Compared

By P. B. McDonald

For several years the Nevada Consolidated and the Calumet & Hecla mines have produced approximately the same amount of metal from ores of nearly the same proportion in copper. The actual mining operations at the two properties are radically different; one is an old underground mine of great depth working lodes of native-copper ore, the other is a 'porphyry' mine extracting low-grade sulphide ore in open pits. One is situated in the attractive Lake Superior region, the other in the sage-brush desert of eastern Nevada. The altitude, climate, and living conditions are in strong contrast.

Taking 1915 as a typical year, the two mined almost the same quantity of ore, 3,077,811 tons at the Nevada mine, and 3,188,583 tons for the mine in Michigan. The Nevada Consolidated recovered 21.61 lb. of copper per

ton, the Calumet & Hecla recovered 22.28 lb. per ton. That the figures are so closely alike is a striking coincidence, particularly when the totally different character of the two mines is considered. The cost to the Nevada Consolidated during 1915 of putting refined copper on the Atlantic seaboard was 8.23c. per pound; this figure, in the words of Pope Yeatman, consulting engineer, includes "all possible charges, such as shipping, refining, marketing, legal expense, taxes, New York and Nevada expenses, and plant and equipment depreciation." The cost to the Calumet & Hecla of producing copper during 1915 was 9.33c. per pound. While this is more than a cent higher than for the Nevada Consolidated, it is partly compensated by the fact that the C. & H. received a price for its copper

nearly a half-cent per pound over the price received by the Nevada Consolidated.

The annual productions of the two mines for seven years is as follows:

	Nevada Consolidated lb.	Calumet & Hecla lb.
1910	62,772,340	72,672,469
1911	*78,541,270	74,130,977
1912	63,063,261	67,856,429
1913	64,972,829	45,916,890
1914	49,244,056	53,691,562
1915	62,726,651	71,030,518
1916	†85,000,000	†80,000,000

*15 months.

†Estimated.

The question of cost of production is an important one for companies treating low-grade ore from which the recovery of copper is but slightly over 1%. An ore of 1% copper means 20 pounds of copper per ton. To produce the metal at 10c. per pound requires a cost for mining, milling, smelting, freight, transportation, construction, overhead, development, and miscellaneous of only \$2 per ton. Taking one year with another, the cost of C. & H. copper is generally given at 10c., that of Nevada Consolidated at 9 cents. The cost at the two mines is apportioned quite differently. At the C. & H., the cost of milling and smelting is relatively low, being not to exceed 2c. per pound. At several of the copper-mills in Michigan, the cost of milling is as low as 1c. per pound on the finished metal. The cost of smelting is perhaps 0.5c. per pound. Any close analysis of the operations of the C. & H. is difficult because the costs on the conglomerate ore, which contributes two-thirds of the mine's output, are higher than those for the amygdaloid ore, which, however, contains less copper per ton. During last year, the C. & H. treated 1,739,984 tons of ore from its famous conglomerate lode, about 55% of the total tonnage milled, and 1,448,599 tons from the Osceola amygdaloid lode, constituting the remaining 45%. The conglomerate ore was more than twice as rich as the amygdaloid ore, yielding 29.74 lb. of copper per ton to 13.32 lb. per ton of the amygdaloid. But the conglomerate ore is both more expensive to mine and the amount in reserve is not large. It is used to sweeten the low-grade amygdaloid. The higher costs on conglomerate are due to the greater depth of underground workings, the consequent heat at that depth, the expense of timbering a loose hanging wall, and the tough angular character of native-copper conglomerate which makes drilling, shoveling, and stamping more expensive. Taking the figures for last year, the mine cost per ton of conglomerate (excluding construction) was \$2.13 per ton. For an average of 29.74 lb. of copper per ton, this means over 7c. per pound on the metal produced as the charge for mining. The total cost of producing copper from conglomerate ore is given at 8.69c. The difference between 7 and 8.69c., or 1.69c., must pay for construction, the cost of which is always high at these mines, for smelting and refining, freight, selling, and all miscellaneous expense. Considering the amygdaloid ore, which in

1915 averaged 13.32 lb. per ton, and for which the mine cost per ton of ore (excluding construction) was \$1.07, this shows a cost of over 8c. per pound of metal to be charged against mining. The total cost of producing copper from amygdaloid ore was 9.71c. per pound, leaving only 1.71c. per pound for all other expense. It is evident that the problem at Michigan copper mines is largely one of cheap mining. The milling and smelting are comparatively simple, the freight-rate to the Eastern market is low by reason of lake transportation, and the selling cost of such an established brand of copper, so much in demand, is small. It is apparent why the management decided a few years ago to conduct a vigorous campaign to lower the underground cost of mining.

At the Nevada Consolidated, the ore was extracted in 1915 for a mining cost of 15.24c. per ton. To this must be added about 25c. per ton for redemption cost of removal of overburden. This capping averaged 155 ft. thick at the Liberty pit, 101 ft. at the Hecla pit, and 87 ft. at the Eureka pit. The redemption cost for the three pits are respectively 30, 22, and 15c. per ton of ore. Taking the average redemption cost at 25c., the total cost of mining becomes 40c. per ton. For ore yielding 22.28 lb. of copper per ton, this figures only 1.8c. per pound of a total cost of 8.23c., a proportion of 22%, against much heavier proportion at the Calumet & Hecla. The cost of concentration is relatively high at the Nevada Consolidated, in spite of the fact that the ratio of concentration is low, being 7.18% for 1915; this contrasts with the approximately 70% metal in the concentrate shipped from the Michigan mills. Only 70.18% of the copper in Nevada Consolidated ore was recovered. It is impossible to compare this with extraction at the Calumet & Hecla, for the simple reason that practically no assaying of Copper Country ore is done. It is not practicable to sample native-copper ore that varies from fine specks to huge masses in a most irregular way. The extraction of copper from Michigan ore has been improved during recent years, notably through the work of C. H. Benedict, metallurgist for the Calumet & Hecla, who pointed-out that in order to save fine particles of copper it was necessary to grind the ore closely enough to liberate these fine particles. Yet it is not likely that the extraction on Michigan ore is radically better than at the Nevada Consolidated. The latter has its own smelter, differing in this respect from the other porphyry-copper mines. As compared with smelting in Michigan, an additional cost comes from roasting the ore before treatment, the proportion of pyrite being relatively high. Freight to the Atlantic seaboard is higher than at Lake Superior, and the general expense of operating in a region where freight and labor are expensive conduce to larger items of cost.

In most ways, except output and grade of ore, these two great copper mines are radically different. The Nevada Consolidated is controlled through ownership in 51% of its stock by the Utah Copper Co., of which, in turn, the Kennecott Copper Co. owns 25%, together with a control of the Braden Copper Co. The Calumet

& Hecla controls a dozen other Michigan copper mines by various stock holdings; the combined output of these subsidiaries is approximately equal to that of the parent mine. Incidentally, the debt incurred in 1908, in consequence of taking over these outside properties, has been almost paid by purchasing the 10-year notes. The Calumet & Hecla recently celebrated the 50th anniversary of its operations, the present company having been organized in 1871, forty-five years ago. The Nevada Consolidated was organized in 1904, twelve years ago. The Calumet & Hecla employs 5000 men, and with its subsidiaries 9000 men, which is more men than is engaged in mining in the entire State of Nevada. The Nevada Consolidated is generally understood to be controlled by the Guggenheims, although their ownership of stock in the company is relatively small. D. C. Jackling is vice-president, and C. B. Lankenau is the resident manager. The Calumet & Hecla is controlled by the Agassiz and Shaw families of Boston, the company having been formed by earlier members of these families when copper mining in this country was in its infancy. James MacNaughton is resident manager and one of the five directors.

As to profit, it is well known that the Calumet & Hecla is the most profitable mine in the world, having paid over \$130,000,000 on a paid-in capital of \$1,200,000; in one year, 1899, dividends of \$100 per share were paid. The Nevada Consolidated has a capital of \$10,000,000, and has paid dividends in the seven years since 1909 of over \$20,000,000 or \$10 per share compared with the par value of \$5 per share. The mine has an assured life of at least 15 years more. This is not a bad record.

Minerals Through the Canal

According to the *Canal Record*, among the 50 principal commodities passing through the Canal during the year ended June 30, 1916, totaling 2,417,46 tons, the following are of interest to mining men:

Mineral	Atlantic to Pacific, Tons	Pacific to Atlantic, Tons	Total, Tons
Nitrates	60	894,079	894,139
Refined petroleum	260,540	10,501	271,041
Coal	213,211	5	213,216
Crude oil	50,033	19,779	69,812
Iron ore .....	.....	52,250	52,250
Copper	849	35,851	36,700
Copper ore .....	.....	17,940	17,940
Chrome ore .....	.....	25,920	25,920
Zinc concentrate .....	.....	22,079	22,079
Tin	9,205	6,004	15,209
Iron	8,364	4,152	12,516
Cement	11,697	.....	11,697
Explosives	6,986	4	6,990
Lead	476	5,713	6,189
Chemicals	5,207	664	5,871
Gasoline	91	1,936	2,027
Lubricating oil	6,904	23	6,927

During June a total of 124 ships, totaling 400,044 tons passed through the Canal.

Diesel Engines for Mine Power-Plants

By Charles Legrand

*At the Burro Mountain Copper Co.'s plant at Tyrone, New Mexico, are two 5-cylinder, 2-cycle Diesel oil engines, the largest stationary engines of their type in the United States, operating at an altitude of 5550 feet. They drive, direct-connected, two 815-kva., 60-cycle, 3-phase, 6600-volt, 180-r.p.m. generators. The current is used for hoisting ore, driving air-compressors, electric locomotives, and a 1500-ton concentrating plant $3\frac{1}{2}$ miles distant. The load is extremely variable.

These engines are of the vertical design, rated at 1250 h.p. at sea-level. The cylinders are 20.6-in. diam., with 26-in. stroke. Each engine has a scavenging cylinder of 41.25-in. diam. and 23.6-in. stroke; also a 3-stage, 4-cylinder, high-pressure vertical compressor, both directly connected to the engine. This compressor delivers the air necessary for fuel injection and for starting the engine. The scavenging pump, which is larger than usual, delivers air to blow-off the products of combustion and fill the cylinders with fresh air at the beginning of the stroke. This pump was increased in size to be able to fill the cylinders with air at $2\frac{1}{2}$ -lb. gauge pressure at the beginning of the stroke. This gives nearly the same initial absolute pressure, and allows the engine to generate nearly the same indicated horse-power as it would at sea-level. The work done in the scavenging pump is, however, increased and the horse-power available is approximately 95% of sea-level output. The fuel consumption per horse-power is increased over sea-level conditions on account of the extra work of the scavenging pump, and the resulting lower mechanical efficiency of the engine when operating at the elevation of this plant.

Fuel used is California asphaltum base oil, averaging 16 B. and 18,360 B.t.u., costing \$1.85 to \$1.98 per barrel. This is heated to 120°F. Oil of 25 B. is used at the start. Consumption of oil is about 0.78 lb. per kw.-hour.

The cost of power, based on total power generated less that used for auxiliaries in power plant in May 1916 was \$0.0080935 per kw.-hour available. The load factor is 0.62.

Operation of the engines in parallel is satisfactory, even when the load is light. In actual operation, with one engine in service, the peak load carried has been higher than was expected.

The greatest trouble with the engines, not due to carelessness, is with the helical gears driving the cam-shaft. The amount of lubricating oil consumed is being reduced, while the maintenance charge is also expected to come lower. On the whole, operation of the plant has been satisfactory, and the cost is considerably better than with a steam plant of the same capacity run under similar conditions, amply justifying the extra investment for this type of engine where the cost of fuel-oil is high.

*Abstract of paper written for Arizona meeting of the American Institute of Mining Engineers.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

PATENTS to the number of 1036 were issued in one week by the U. S. Patent Office during July.

FITCHER is a good technical term. It signifies the jamming or sticking of the steel in a drill-hole, as happens in ground that is seamy.

AIR-HAMMER drills were probably used first for drilling holes for blasting in the quarries of New England. They were adapted from pneumatic riveters to drill plug-and-feather holes.

AEROPLANES to the number of 398 were exported from the United States in 1915. The value was \$2,960,814, an average of \$7439 per machine. A large export of aeroplane parts was also made.

COMPRESSED AIR is employed by French soldiers in the trenches for throwing bombs. Four men work with bicycle-pumps to make a high pressure of air, and the bomb is shot noiselessly from a piece of pipe improvised as a cannon.

THE COPPER ORES of Butte average 3% copper and 2 oz. silver per ton. The proportion of copper recovered from its ore by the Anaconda company has been increased from 77 to 90%. On 3% ore, this additional saving of 13% represents about 8 lb. of copper per ton.

BLASTING in the bottom of a well is a remedy for increasing the flow of water. It is related that an old well 35 ft. deep "was not providing enough water for a horse to drink." The bottom of the well was partly in rock. A man climbed down and put two cartridges of dynamite in the rock. After the shot, the flow of water was plentiful and clear.

SULPHURIC ACID for use in the leaching process of the New Cornelia Copper Co. will be furnished by a new acid-plant under construction at the Calumet & Arizona smelter at Douglas. This acid-plant will have a capacity of 200 tons per day. The acid will be produced from roasting sulphide copper ores on 24 Herreshoff roasters. At the New Cornelia mine, the acid will be conducted from tank-cars by gravity directly into four storage-tanks of a combined capacity of 150,000 gallons.

STARTING A PUMP that has been under water for over a year is illustrated by an accident at a Montana mine. A pump in the Butte & Zenith mine was under 275 ft. of water. It was of the duplex-sinker type and was in a horizontal position. Compressed air was turned into the pipe-line, and the pump started almost immediately although it had been idle for 15 months. It ran until

the water was lowered 65 ft., when trouble arose in the air-compressor. After the compressor had been repaired, the pump could not be started again, until superintendent Gibson turned 100 lb. of pressure on the air-column, with the pressure released on the water-column, forcing the plunger back. The pump started again and was kept in continuous operation until the shaft was unwatered.

A WATER-SUPPLY was obtained for the plant of the New Cornelia Copper Co. by sinking a 650-ft. shaft in the desert eight miles north of Ajo. Drilling had first demonstrated that water existed there. An electric-pump forces the water through a 10-in. pipe-line to large steel storage-tanks on a hill at the mine, the lift of the pump being 1100 ft. The water is alkaline and of a temperature of 102°F.

A MULE-DRIVER in a Kentucky mine was kicked by a mule, which he had struck with a whip. He tried to recover damages for injuries received. The judge of the Court of Appeals in denying the plea, said, "The mule would have been untrue to itself and to every tradition of its breed, if it had kept its heels on the ground, and an employee cannot court danger by inviting a mule to kick him and then recover for consequent injuries."

BLACK blasting-powder is a mechanical mixture of finely pulverized sodium nitrate with charcoal and sulphur. In making black powder, the original cakes are broken into small grains. These are put in a revolving barrel and are rounded by rubbing together, lessening any tendency of the grains to absorb moisture from the air. The ordinary black powder used in mines and quarries is 73% sodium nitrate, 16% charcoal, and 11% sulphur. The powder is sold in grades varying with the size of the grains, which are as large as $\frac{1}{2}$ in. and as small as $\frac{1}{16}$ inch.

AIR SHOCKS from the explosion of shells have killed men in the trenches on European battlefields. It was noticed after artillery battles that many bodies bore no apparent wounds, and evidently death had come from instantaneous stoppage of the circulation. According to *La Nature* of Paris, the explosion of a high-power shell causes a considerable barometric depression equivalent to the exhausted atmosphere at the top of Mount Blanc, 15,000-ft. altitude. A sudden barometric depression, similar to the experience of an astronaut who descends too rapidly, separates from the blood the air and carbonic-acid gas normally held in solution, and these bubbles become caught in the capillaries and stop the flow of blood instantly. Death occurs from 'gaseous embolism.' This is similar to the form of paralysis, known as the 'bends,' that afflicts miners or 'sand-hogs' working in compressed-air caissons, when, on coming out, they do not remain in the reducing-chamber long enough. These phenomena are dangerous only when the change is too sudden; if the transition is gradual, the blood takes care of the bubbles of air.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

SUTTER CREEK, CALIFORNIA

PROBABLE LAIDOR TROUBLE.—KEYSTONE, OLD EUREKA, ARGONAUT.

An announcement has been made by the following mining companies of Amador county that any demand for a material increase in wages and shortening of hours of labor will be refused and that if such demand be insisted upon, the mines will be closed indefinitely: Plymouth Consolidated, Fremont Consolidated, Bunker Hill, Treasure, Keystone, Original Amador Consolidated, Consolidated Amador (Old Eureka), South Eureka, Central Eureka, Kennedy, and Argonaut mining companies. As a reason for this attitude, the mine-owners call attention to the fact that while the price of copper has increased, the price of gold remains unchanged. The price of supplies such as timber, powder, tools, rails, etc., has considerably increased, and the industry in general is being conducted at a small profit. Attention is also called to the fact that the companies recently made a voluntary increase of 25c. per day in wages. Whether this announcement will have the effect of deferring the threatened strike remains to be seen. Rumors are now current that the walk-out will take place on September 9.

The 1800-ft. station is now being cut in the Keystone shaft at Amador City, and following the company's usual custom the station will be large and well equipped. In this mine, the veins worked in the levels above give evidence of converging at depth, and considerable good-grade ore is known to exist below 1400 ft., so there are excellent indications of opening a large reserve of ore by means of the stopes that will be opened above the 1800-ft. level. Notwithstanding a large amount of dead work done during the past six months, a profit of nearly \$14,000 has been made. The Keystone property has been in almost continuous operation since its discovery in 1851 and has yielded well, although shallow in depth compared with its neighbors. The present company sank the shaft from the 1400 to the 2400-ft. level, equipment has been materially improved, and general conditions are good for economically handling ore opened by the last year's development work. C. R. Downs of Sutter Creek is manager and B. I. Hoxsie is foreman.

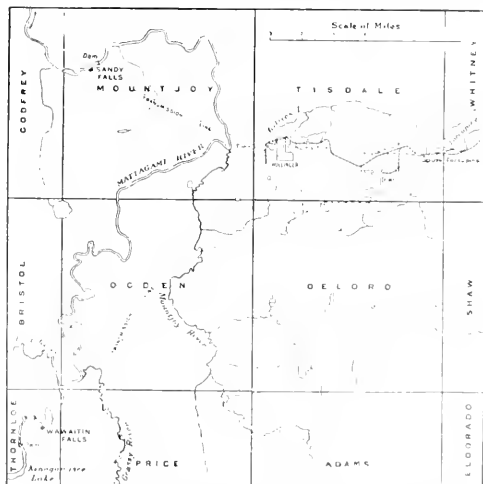
Water has been removed from the Old Eureka shaft to the 600-ft. level, and the shaft-timbers above that point have been repaired. Another sinking-pump will be installed so as to unwater more rapidly the levels below. Fairly good progress is expected until the 800-ft. level is reached. It is understood that the fire which caused the shutting-down of the mine 30 years ago did most of its damage at and below this depth. Grading on the steep hill-side is now in progress in preparation for the erection of a modern steel head-frame, but the present one-reel hoist with low wooden head-frame is adequate for current needs. Construction of a timber-shed is well under way, and machinery for the modern saw-mill will soon be installed. A crew of about 25 men are employed, including three shifts of shaft-men.

Carpenters are now engaged in completing the interior of the new 60 stamp-mill at the Argonaut and putting on the corrugated-iron roof. The building is situated on the highest part of the ridge west of the present plant, so there will be no difficulty in the tailing following by gravity to the large dam prepared for the residue. The old 40-stamp mill continues to make a monthly profit of over \$25,000. Interesting tests are made at this plant most of the time.

TORONTO, ONTARIO

FIRES ENDANGER MINING DISTRICTS.—RICE LAKE.—NICKEL.

The forest fires that devastated large portions of northern Ontario four weeks ago, causing a loss of over 200 lives, threatened to destroy the Porcupine district. The mining centres escaped serious losses, with the exception of Munro township, where several lives were lost and the surface plant of the Croesus mine was completely destroyed. A number of prospectors in this area also perished. In some mineralized sections the destruction of vegetation has left the rocks bare, thus facilitating prospecting. The burned-out settlers are being given prompt relief, and the towns destroyed will be rebuilt as quickly as possible. The fires are supposed to be caused by the carelessness of settlers who start fires during



MAP SHOWING WATER-POWER AVAILABLE FOR PORCUPINE

dry weather to clear their land. The disaster has drawn attention to the defects in the fire-ranging service of the Province, and above all to the necessity of strict official control of all clearing operations.

A New York syndicate represented by Henry Cecil of Baileybury, has purchased from Angus MacDonald, discoverer of the Rice Lake goldfield in Manitoba, the properties known as the Gold Pan, Gold Seal, and Gold Pan Fraction, covering 117 acres, the price being reported at \$500,000. It is understood that Bache & Co. of New York are heavily interested. Development will be started without delay, and the equipment has been ordered. The company will be known as the Gold Pan Mining Co. There is now a shaft 125 ft. deep at the Gold Pan.

Notwithstanding reports to the contrary, the site of the Canadian refinery to be erected by the International Nickel Co. has not yet been finally decided upon. The company is understood to have an option on a site at Port Colborne on Lake Erie, but the matter is still unsettled, and it is not un-

likely that a place in northern Ontario may be selected. Meanwhile many centres are making strong efforts to secure the refinery. The question of compelling the refining of all nickel ore in Canada is much to the front in politics. A by-election for the Ontario Legislature is now in progress in Toronto, and the Liberals are endeavoring to make this the principal issue. The building of the International company's branch plant in Canada will not settle the matter by any means, so long as political capital can be made by agitating for more extreme measures.

JOHANNESBURG, TRANSVAAL

REDUCED DIVIDENDS AND PROPOSED DEEPER MINING.

Although statements have been made recently in the Union parliament at Cape Town to the effect that the Transvaal gold mines "are having the time of their lives," a little reflection will show that the speeches made and the results indicated at the many annual meetings of shareholders recently held are giving some cause for alarm. While last year's dividends were less than those in the previous year, there is a considerable decrease in the distributions during the first six months of the current year, compared with the corresponding period of 1915. The three great producers, the Crown Mines, East Rand Proprietary, and Rand Central Mines, whose combined nominal capitals approach £8,000,000 and whose size, development, and equipment were supposed to make results independent of any reverses, are causing stockholders some uneasiness. Take for instance the Crown Mines, the largest gold producer on the Rand. Its declared dividend was only 25% in the last six months, against 20% for the previous half-year, and 35% for the corresponding period of 1915. Such a heavy decline was never expected. The last half-year's unsatisfactory results have been largely brought about by the adoption of the engineer's method of selective mining, which, while it increased the grade of ore sent to the mills by 50 cents per ton, increased the cost to a corresponding extent, and the reduced tonnage treated decreased monthly working profits by something like £20,000. The method adopted was to reduce the stoping widths by leaving the poorer portion of the "reef" in the hanging wall, by substituting hand for machine stoping. The result of this new method was to increase the proportion stoped by hand from 14 to 56%; but although the number of stopes was increased by 37, it was found impossible to send the same quantity to the mills with the above results. Needless to say the former method of working is being reverted to as quickly as possible. Another novel method of testing deep ground is being introduced at the East Rand Proprietary Mines. At a vertical depth of 4000 ft., throughout the whole length of the property, payable ore has practically disappeared, and every effort to discover good ore has failed. With 170,000 tons treated per month, and milling reserves reduced to 4,800,000 tons, some method of expediting the discovery of ore has, if possible, to be adopted. There is a great area south of the three deep shafts still unexplored, but of somewhat doubtful value, on which the future of the East Rand Proprietary depends. At the southern limit of this area the reef probably approaches a vertical depth of 8000 ft. In order to probe this area as soon as possible, it is intended, in addition to following the reef on the incline, to drive two cross-ends from the two Angelo Deep shafts at a depth of 4000 ft., a distance of 1000 ft., and then put down a vertical shaft to the reef supposed to lie at a further vertical depth of 2000 ft. It is anticipated that this will occupy 1 year and cost £200,000. Whether the reef will be found profitable at such a depth as 6000 ft. seems problematical.

In *The Mining Magazine* for August, the Far East Rand and suggested changes in the gold law are discussed by R. N. Kato, this being an abstract of a Government report; also "The Far East Rand and the Government," by H. Foster Bain, who recently personally studied the question.

LONDON

FUTURE OF ZINC SMELTING IN ENGLAND AND EUROPE.—ZINC CORPORATION AFFAIRS.

The great increase in spelter production in the United States has attracted much attention on this side and, especially now that prices have tumbled, questions are being asked as to what the condition will be after the War. It is to be remembered that in pre-War days the world's smelting capacity was equal to its demand for spelter. In the normal course of events consumption would have grown and additional furnaces would have been needed by now. When the various nations again settle down to industry it is fair to assume that the tendency toward increased consumption of zinc, which has been a feature of the metal industry for years, will re-assert itself. There will, however, be an excess furnace capacity. So far as is known, no considerable portion of the pre-War furnaces has been wrecked. The big chimney of the Overpelt works of Beer, Sondheimer & Co. was blown down by the Belgians and other damage done to the works, and Belgian plants near Liege have suffered some damage. It is impossible also to foretell what may happen if the Germans move out of Belgium. Many of the works are in the probable line of fire and if the retreat be bitterly contested, further damage is to be anticipated. In a large way though it is true that no considerable amount of plant has been wrecked, and at the end of the War the furnaces that used to supply the world's demand for spelter will still need to be taken into account. Staff and men will be scattered and many will be dead, but the gaps can be filled, supplies purchased, and in general, the old business can be re-established. If this is not done, the men will work at something else, the plants be converted, and competition will merely be diverted to new channels. The Germans have a large and probably adequate supply of ore within their own boundaries, and, while they were formerly extensive buyers of ore in Australia and elsewhere, but a small part of what they purchased was actually treated in Germany. If the flow of concentrates from Australia to Europe be diverted, it will be Belgian and French furnaces that will suffer more than those actually in Germany. These facts are beginning to be understood here and, without in the least abating the determination to free the world from German domination of the metal trades, the method is receiving more serious thought than at first. Your own greater expansion of smelting capacity is a matter which gives us pause. Doubtless many of the furnaces now in commission in the United States will not be able to run under normal conditions, but among the new plants are evidently a number which, being well built and well financed, can stand competition as well as any in the world. With your domestic ore supplies and these new furnaces, it is to be expected that you will play a larger part in the world's spelter market than in the past. There are also the new furnaces in Japan, though to the best of knowledge here the Japanese are not well fortified with ore supplies. Doubtless they can supplement their local resources by drawing upon China, but how far is an open question. Russia is striving to develop home resources, and Austrian prisoners are already making spelter at Elkhastus in Siberia. With all these considerations to face, it has not been an easy problem to determine how Britain is best to take advantage of the great resources in zinc ores found within the Empire, and especially at Broken Hill and in Burma. In round figures the pre-War production of the zinc furnaces in Great Britain amounted to 60,000 tons, and the local consumption of spelter was 200,000. Since the War started, additions to local works have been made or contracted for that will about double the capacity. Zinc smelting has been started in Australia and Canada. The ideal held up here is that the Empire, having the ore, should at least make within it borders the amount of spelter called for by its own industries. To do this entirely would, however, interfere with the industries of

Belgium, and there is no disposition to do this. Also, it is questionable economics to multiply too greatly the number of furnaces in a world that will already have an over-abundance. The latest proposals therefore look toward co-operation with the Belgian and French smelting companies as well as the British concerns. As a result of negotiations conducted by W. M. Hughes, the Australian prime minister, it is announced that the Imperial Government will finance the movement of Broken Hill concentrates, as Americans have doubtless already learned. The plan is for the authorities to purchase from the mines 100,000 tons of concentrates per year for 10 years. The Government has also agreed to finance the building of Australian smelters capable of producing 45,000 tons of spelter and to buy the product. The concentrates shipped to Great Britain will be distributed to English smelters for treatment. As a first step the Government has actually purchased from the Zinc Corporation 100,000 tons of concentrate, and is allotting this to the British plants for reduction. This was bought on the basis of £25 per ton for spelter, the Government assuming all cost and risk of shipment. These arrangements are to be extended when circumstances permit so as to provide for such French and Belgian plants as may desire to enter the combine. The French plant at Dunkirk is already being allotted ore. All this "socializes" the British zinc industry, to use a word our socialist friends much affect, to an extent that before the War would have been considered out of the question. In effect, the Government assumes the responsibility of providing a market for the miners and, in part at least, for the smelters. It is to act as broker and in this way control the situation without entering the politically dreaded field of tariffs and subventions. Clearly it may make or lose money, or it may do both in turn, but also clearly the Imperial government will for some years to come be an important factor in the zinc business and the old *laissez faire* methods are abandoned. So far proposals for buying ore only extend to Australia. What action, if any, will be taken to control the flood of metal that the Burma Mines will soon be ready to supply, remains unknown.

The contest against the management of the Zinc Corporation that was made at the annual meeting of the shareholders is being continued though with scant success. The system of ownership of British companies when those in control take every means to increase the number of shareholders, opens the way to contest whenever anyone is disposed to spend the money and energy necessary to circularize minor owners. In practice such contests are not common and rarely amount to much. In this instance F. C. Auld, who has in the past achieved some success in such matters, attempted to control the annual meeting but failed. He has since tried to form a committee to pursue the contest but has met with a series of resignations. First W. Graham resigned giving as his reason that a circular had been issued in which he was mentioned as connected with the *Financial Times*, whereas his intention in joining the committee was to act in his private capacity. Sir Edward Samuel was announced as his successor but has issued a letter saying he gave no permission for the use of his name. Later E. Rodocanachi withdrew so that of the original list there now remain only Mr. Auld and three others two of whom have no financial interest in the Corporation. The attempt to interfere in company management by men, none of whom have a large interest and some of whom have none, will probably appeal to American readers as most peculiar, but it is to be remembered that in London company management has become almost a profession, with little relation to the particular business in which the company is concerned. As to the merits of this particular contest, which seems doomed to die before it gets properly started, it may be fairly said that no one who has studied the history and present condition of the Zinc Corporation takes the matter seriously.

On page 372 of this issue electrolytic zinc in Australia is discussed editorially.

LEWISTON, MONTANA

LARGE CEMENT PLANT STARTS WORK.—JUDITH MOUNTAIN COPPER DEPOSITS.

The Hanover Gypsum Co. started its new mill 8 weeks ago. Soon after, the new mill, 1000 acres of land, and the remainder of the property was sold to the Three Forks Portland Cement Co., which operates Montana's only cement plant at Trident. This concern is controlled by Chas. Boettcher and associates, who have already started work on a \$1,000,000 cement plant to be built on the property just purchased near Lewistown. This will be rushed to completion in the next few months, and it is expected to supply much of Montana and the Dakotas from the new plant. Abundant deposits of pure limestone outcrop less than two miles away in the South Moccasin mountains, which can easily be transported by gravity tram to the proposed plant. Extensive beds of clay suitable for cement manufacture also are found nearby.

Mining and prospecting in the Judith mountains is more active than for many years. The Spotted Horse, Cumberland, and MacGinness mines at Maiden are producing regularly. Ore has also been shipped from the War Eagle, and from prospects on the north and east side of the mountains. It is reliably reported that the four lessees of the Cumberland have refused an offer of \$250,000 for their lease and bond, as a result of the recent rich development; at any rate Milo Skerrow has sold his one-fourth interest in the lease to George Wiegand, one of his partners, for \$25,000.—The Mammoth claims near Gilt Edge have been leased after being closed for nearly 10 years; development work is now in progress and it is expected to soon re-open the mill with which the property is now equipped.—Several lead-silver and gold claims in the Cone Butte district, east of Maiden, are opening well, some are being shipped.

One of the most interesting developments this summer is finding copper ore in commercial quantities in the Judiths. On the north side of Red mountain are five claims controlled by E. Sutter and others of Lewistown. Already one car has been shipped, from which it is expected to realize a profit of \$1800 above smelting charges; more ore will follow. The ore mined averages 21% silica, 18% copper, and 25% iron, and includes azurite, malachite, chrysocolla, and the black earthy oxide, melanconite, and some cuprite. Development so far is not extensive, but indications are favorable for the occurrence of a large sulphide orebody in depth. On the Sutter 1, 2, 3 claims oxidized ore occurs in rather irregular bodies in intrusive rhyolite-porphry near limestone. A heavy iron gossan overlies the deposit and there is evidence that the surface ores have been leached, which may indicate a zone of secondary enrichment in depth. In West Annell's Creek valley, a few hundred yards away, there is a vein of pyrite carrying gold and copper. On the Missourian claim somewhat farther away, the copper ore is found near a dike of phonolite. On the south side of Red mountain are four claims owned by Sutter brothers and Hawkins, on one of which, the Copper King, a face of 60 ft. of 1 to 3% copper is exposed. Others have staked claims nearby and considerable interest has been aroused.

In the North Moccasin mountains both the Barnes-King and Kendall properties are regularly producing. Development is being done on the West Kendall, where considerable lead ore carrying gold has been found, and on the North Kendall where a body of low-grade gold ore is being sampled. The Barnes-King company continues to improve its surface equipment.

Oil and gas locations are still attracting interest. Recently the Grass Range Oil & Gas Co. has been organized to prospect for oil on 10,000 acres of leases ten miles S. Range, 35 miles east of Lewistown. Still farther east in the Cat Creek basin near Winnet, Warren C. Wright of Chicago has leased 100 acres on a pronounced anticline, and expects to begin drilling in a few months.

THE MINING SUMMARY

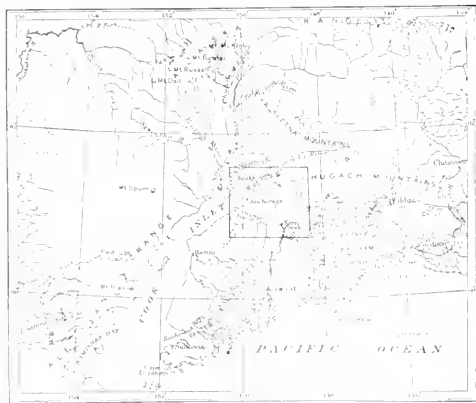
The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

In Bulletin 642-E of the U. S. Geological Survey, Stephen R. Capps discusses the Turnagain-Knik region. This report covers 48 pages, accompanied by maps. The geology, gold deposits, mines, and prospects are described in detail.

The Cosna-Nowitna and Ruby-Kuskokwim regions are described in Bulletin 642-H by H. M. Eakin, J. B. Mertie, Jr., and G. L. Harrington. The area is east of Fairbanks.

JUNEAU. Commenting on affairs at the Alaska Gold Mines, D. C. Jackling recently made the following remarks: "Conditions are not at all discouraging. As far as we are concerned we pay no attention to stock-market prices. We are interested in the mining end of it. The operating costs are about 65c. per ton. Conditions at Juneau are different than in some other mining properties. We have to take the ore that we have on hand and dispose of it before we can get at other ore. At present we are opening the mine in some new places, and this will probably soon result in an improvement. Conditions are not as good as we expected, nor as good as we ex-



MAP INCLUDING THE TURNAGAIN-KNIK REGION.

pect they will be. But we have faith in the property and believe that we will run into better ore that will show good profits later. Our July report showed the ore was averaging \$1.21 per ton, an improvement over the average shown by the ore treated in previous months. The average for last year was a little over \$1.15 per ton. We look for still further improvement, after the ore that is broken and ready for the mill is disposed of. Alaska Gold is a long-time proposition and must be worked out gradually, as it has an enormous tonnage."

July returns of the Treadwell group were as follows:

	Mexican	Treadwell	United
Ore crushed, tons	14,385	77,721	45,010
Gold yield	\$19,122	\$157,165	\$74,052
Average per ton	1.33	2.03	1.64
Operating expenses	22,096	98,727	77,145
Construction charges	2,124	12,326	11,338
Profit		14,827	
Loss	5,589		15,171
Other income	3,730	11,281	3,730

ARIZONA

BISBEE. Flotation experiments on low-grade silicious gold-silver-lead ores are now being made at the Shattuck-Arizona mine. During July the yield was 315 oz. gold, 22,525 oz. silver, 174,091 lb. lead, and 1,397,445 lb. copper.

CHLORIDE. Firemen and cage-men at the Tennessee mine asked for a raise of 50c. per shift, and because this was refused the whole force at the mine, 175 men, downed tools. An offer of 25c. was made but refused by the men. Water is likely to be a trouble if the pump-men walk out.

OATMAN. At the United Eastern's No. 2 shaft raising has been started from 690 ft. to meet sinking from 590 ft. At the mill two ball-mills have been erected. Three tube-mills are ready to be installed.

CALIFORNIA

ALLEGHANY. On October 4 a meeting of the Tightner Mines Co. is to be held at Grass Valley to consider increasing the capital from \$100,000 to \$750,000, also to change the par value of shares from \$1000 to \$10 each. The mine continues to yield rich ore.

ATURN. The north fork of the American river, between Auburn and Colfax, is to be prospected by the Guggenheim interests. A large drill is being assembled.

HAPPY CAMP. The Gray Eagle mine, known locally as the Dakin & Farish property, 7 miles from Happy Camp, up Indian creek, in Siskiyou county, has been sold to Charles F. Ayre, representing W. B. Thompson of New York. An examination had been made previously by Orvil R. Whitaker. This is a developed copper (chalcocopyrite) mine, with 500,000 tons of 5% ore assured. Evidence indicates this to be one of the most important copper developments in California since the Mammoth came into prominence.

JAMESTOWN. On the 800-ft. level of the Knox & Boyle shaft of the Nyman Consolidated, after driving 30 ft. through the fault the north orebody was cut. Two feet assays \$50 per ton. Ten stamps are crushing 3 tons per day each of \$15 ore.

MARYSVILLE. On August 23 the Pacific Gold Dredging Co., a subsidiary of the Yukon Gold Co., launched a new dredge a few miles above this place.

(Special Correspondence.)—It is expected that the Excelsior mine, situated near Sugar Pine, will be re-opened and operated in a vigorous manner. The property, which produced around \$400,000 in the early days of quartz mining in this county, when a shaft was sunk to a depth of 225 ft., was recently inspected by H. L. Huston, of San Francisco, who, it is understood, will report favorably to the prospective purchasers. The Excelsior is owned by Fred Sutton of Sonora.

Operations will begin soon at the Omega mine, now unwatered to a depth of over 300 ft. While the pumps are taking out the remaining water, the drifts on levels No. 1, 2, and 3 are being re-timbered preparatory to the extraction of ore and further development. It is the intention later to drift from the bottom of the 600-ft. shaft to open the orebodies exposed in the workins above.

Boston people have taken the Bell mine under bond and will begin operations at an early date under the direction of Paul S. Bernard. The ore is low grade, but the vein is large and the property is regarded as one of the most promising in the Tuttle town district.

The Rawhide, which is in the hands of the Silver Peak Mining Co., is being equipped with powerful modern ma-

chinery for extensive development. It has been unwatered to a depth of 1200 ft., and the pumps are still working.

The Cosmopolite mine, near Groveland, has been bonded to a Nevada company said to be strong enough financially to give the property a thorough trial. It is understood that vigorous work will begin at once.

Sonora, August 26.

WOODY. Contracts were let on August 28 by the Weringer Mines Co. for machinery, including a Hardinge ball-mill, Dorr classifier, and Oliver filter, for a flotation plant to treat the sulphide ores of the company's property. These machines will be supplied by Collins & Webb of Los Angeles. A 160-hp. Western gas-engine was also purchased from the Western Gas Engine Corp. of Los Angeles. C. H. White of Cambridge, Massachusetts, is reporting on the Weringer property.

COLORADO

BRECKINRIDGE. The Breckinridge district is shipping 2900 tons of ore and concentrate per month. The largest producer is the Wellington Mines Co., which sends out zinc ore and concentrate. The Comnack company has recently completed a new mill. The Tonopah Placers and French gulch dredges send their gold regularly to the Denver mint.

CRIPPLE CREEK. The Cresson company is to pay dividends of 10% monthly on the 1,226,000 shares, which are now selling at \$5.50 each, \$1 par value. This is equal to \$1,400,000 yearly.

The Independence mill has been stopped, pending re-modeling, which will occupy the remainder of the year. It will then have a daily capacity of 1200 tons, double that at present.

Gold output of the district during August is estimated as follows:

Plant	Tons	Average value	Total value
Golden Cycle, Colorado Springs...	36,800	\$17.00	\$625,600
Portland, Colorado Springs.....	13,000	21.00	273,000
Portland, Victor	19,600	2.85	55,860
Portland, Independence	16,958	1.94	32,898
Caley-Jerry Johnson	2,400	4.00	9,600
Rex	1,860	2.40	4,464
Reed-Gold Sovereign	700	2.50	1,750
Worcester-Rubie	300	2.40	720
Smelters, Denver and Pueblo ...	4,630	55.00	254,650
	96,248	\$13.07	\$1,258,542

On October 1 the Doctor-Jack Pot company pays 1c per share, equal to \$30,000. Profits in the second quarter were \$12,315. Cash assets are \$139,083. The ore averages \$8.55 per ton.

Sinking has been temporarily suspended at the main shaft of the Strong mine at Victor, where a depth of 1500 ft. has been attained. A station for the fourteenth level is now being cut out. Cross-cutting will then be started.

The United Gold Mines Co. has taken a lease on the old Victor mine belonging to the Smith-Moffat estate. Part of the ground will be sub-leased, either on the split-check system or on a slight increase in royalty over that paid by the leasing company to the estate.

LEADVILLE. The Mt. Champion mine is probably to be sold, and it is now being examined. The price is not stated, but the property is valued at \$800,000. Present production is large.

The mines included in the Down Town basin recently drained are the Bon, Bon Air, Valentine, and Weldons to the south, all of them at one time heavy producers of iron-manganese and silver ore; the Home Extension and Cloud City, now steadily shipping a large quantity of iron-manganese; the Penrose, the centre of draining operations; the Elks, Midas, Hussey, Hilschle, Hope, Wolcott, Sixth Street, Coronado, M. E. C., and Northern, a territory known to be rich in iron-manganese extending almost through the entire city from its north and south limits. The mines in this section were without exception last active before the entrance of carbonate of

zinc into the list of commercial ores to be found in the Leadville district. Shipments of carbonate were made from the Penrose dump after it had been idle some time, and when the water was considered too expensive an obstacle to development. Indications of zinc carbonate have since been found in many other properties in the Down Town basin. This knowledge of the presence of zinc throughout the Down Town area, together with the exceptionally strong market that has prevailed for spelter for some time, were the main factors in bringing about the draining of the territory. Now the water has been removed and mining can again proceed without difficulty.

IDAH0

COEUR D'ALENE

Dividends paid by Coeur d'Alene companies in August totaled \$677,175, making \$6,844,670 in 8 months.

BURKE. The Consolidated Marsh Mines Co. has arranged a 10-year lease on certain claims of the Federal Mining Co. The Marsh company is to spend \$40,000 in the Marsh property. Under the lease the Marsh is to account to the Federal company for milling ore on the following basis: When the ore contains 9% lead or less the royalty shall be 35c. per ton milled, and for each unit of lead above 9% the royalty is to be increased at the rate of 25c. per ton for each unit in excess. This rate is to apply when lead is 5½c. per lb. in New York, and when higher than 5½c. the royalty shall be increased at the rate of 30c. per ton for each cent above 5c. per lb., fractions proportionately. The royalty on crude ore is 15% of the net smelter returns when lead is 5½c. in New York, 20% when the price is 5½ to 7c., and 25% when the price is 7 to 8c. The Marsh company also agrees to pay all taxes, and holds the Federal company free from loss or damage by reason of personal injuries, liens, or other encumbrances.

KELLOGG. July profits of the Caledonia were \$90,000. On September 5 a dividend of 3c. per share, or \$78,150, will be paid. This makes \$677,300 for the year.

MURRAY. It is almost certain that the O. W. R. & N. Co. will construct a railway up Beaver creek. The line has been surveyed. It will serve the Ray-Jefferson, Interstate-Callahan, Idora, Tuscumbia, and Virginia, all producing properties, and the Friend, Toughnut, Parrott, Sunset, and several others that will be able to ship as soon as transportation is provided. A minimum monthly tonnage agreement is said to have been entered into with the companies that will benefit, the deficit, if any, to be subscribed pro rata.

PINE CREEK. It is reported that the Coeur d'Alene Antimony Mining Co. of Spokane, operating near the mouth of Pine creek, is to erect a smelter to reduce its ore and concentrate. The mine continues to open well.

MICHIGAN

THE COPPER COUNTRY

Houghton. Additional men are being taken on by the Calumet & Hecla and subsidiary companies. A good class of miner is being attracted to the district. A 10,000-kw. turbo-generator is being constructed for the C. & H. plant on Lake Linden by the Allis-Chalmers company. This machine is to replace two others of smaller capacity. The new one and another at work will supply 17,500 kw. Power consumption is increasing continually. The new leaching plant is said to be working satisfactorily.

At the Lake mine the old Pelt shaft is being unwatered by means of an air-lift.

Concerning the Calumet & Hecla-Tamarack business, the C. & H. distributed on August 31 to its own shareholders 20,000 Tamarack shares, each holder of 5 shares in the C. & H. getting 1 share of Tamarack. Apparently the sale of the latter to the C. & H. for \$59 per share is off.

Calumet & Hecla shares remain steady around \$540; Copper Range are \$60 each.

MISSOURI

JOPLIN. Flotation of slime is being adopted in this district, although somewhat in the experimental stage. Companies using the process are the Voge at Carterville, Martin & Wilders at Chitwood, Wingfield Bertha A. at Webb City, and Picher at Picher, Oklahoma.

Ore prices were unchanged last week, the average for 60% blende being \$61, 40% calamine, \$41; and 80% lead, \$65 per ton. The total yield was valued at \$332,953, making \$23,230.79 for 24 weeks. August production of blende was 5590 tons less than in any other month of this year; April, the largest, was 42,327 tons; August was 15,749 tons. Surplus ore in bins is estimated at 23,000 tons.

MONTANA

BUTTE. The Anaconda company has recently purchased from the Westinghouse Electric & Mfg. Co. a 1215-hp. synchronous motor that is to be used for compressor service in the Leonard mine.

The Butte-Zenith shaft is down 1000 ft., where a 600-gal. electric pump is to be installed. Cross-cutting is to be started on October 1.

LIBBY. A recent shipment of 2561 lb. of concentrate from tailing at the Rose Consolidated Mining Co.'s property near here returned \$1163 in tungsten, according to Harve H. Phipps of Spokane, the company's president. As this property was purchased as a gold mine, the owners are pleased with this extra yield. The tungsten is a high-grade scheelite, and the ore returns \$5 per ton more than the present market price under the contract. The new 10-stamp mill is completed, and only awaits the erection of feeders and wiring for electric lights. The mill is built so that with small expense the capacity can be doubled by adding a Hardinge mill, tables, and other equipment. Three years of ore is blocked out. One adit was driven at right angles to the vein, cutting it at 350 ft. From this a raise 150 ft. to the surface was made in ore all the way. The vein is from 1 to 5 ft. wide, and averages \$12 to \$20 in gold, with tungsten the whole distance. A second adit cut the vein at the same distance from its portal, and a raise about 180 ft. opened ore all the way, where it is a little wider and a little richer. These two adits and raises are 800 ft. apart. The ore has been further proved by small shafts and surface explorations between the two raises. Oscar Nordquist of Wallace is manager of the Rose Consolidated. P. S. Rose of Libby is superintendent.

SUREDOA. Mining in Mineral county is experiencing a good revival. At the Iron Mountain 110 men are employed. The Inter-Mountain is shipping copper concentrate. The King and Queen near Saltese are opening silver-lead ore. The Tarbox is sinking 500 ft. The Silver Cable and Big Elk are extracting ore.

NEVADA

GOLDFIELD. The annual report of the Jumbo Extension Mining Co. for the year ended June 30, 1916, includes the following:

Development covered 8917 ft., inclusive of 595 ft. of shaft-sinking. Development cost \$6.95 per foot, sinking, \$37.06 per foot. In the Pol-overda claim 1252 ft. of work was done. Two promising stringers did not produce large quantities of ore. Exploration continues at 932 ft. The claim yielded 6400 tons of \$30 ore. In the Velvet claim 7665 ft. of work was accomplished. The output was 39,734 tons of \$5.42 ore. The shale-latte orebody has been stoped steadily from the 920-ft. to the 800-ft. level, over 300 ft. on the dip. A large tonnage still remains there. Raises from the 1017-ft. level are being put up to cut its downward extension. The shale orebody found in 1915 has been worked out. One found at 1017 ft. is not profitable. The Velvet shaft is down 820 ft., and at 730 ft. was connected with the Pol-overda shaft. Extensive work is under way on the 769 and 879-ft. levels. Any estimate of re-

serves would be impossible, owing to the peculiarities of the shale-latte orebodies. Mining and development cost \$5.40 per ton. Tests are being made on dump ore and tailing at the Bonnie Claire mill.

The year's output was 35,541 tons averaging \$31.64 per ton, equal to \$1,124,487. Smelter losses were \$4.32 per ton, leaving \$970,785. Total expenses were \$15.82 per ton, against \$18.97 in the previous year. Four dividends were paid, totaling \$465,000, equal to 30c. per share.

At a depth of nearly 900 ft. the Silver Pick Consolidated has cut 3 ft. of \$25 ore, but a sudden rush of water has stopped sinking for the present. The Calyx drill, working from the 500-ft. level, is at a depth of 1130 ft. Several good veins have been cut.

MANHATTAN. Developments at the White Caps mine are of importance to this district. The ore above 210 ft. had been mostly extracted, water was troublesome, and the ore was rebellious. The shaft has since been sunk to a depth of 310 ft. The east drift is out 300 ft., and cut 12 ft. of ore assaying \$30 per ton. The west drift is 22 ft. in ore of high grade. Treatment problems are practically solved. J. G. Kirchen of Tonopah is in charge.

OKLAHOMA

COMMERCE. A boom continues at this and the other new towns in the zinc-lead district, namely, Cardin, Oklahoma, and



PART OF OKLAHOMA, SHOWING ZINC CENTRES.

Picher. The mines have grown at a rapid pace. The ore, which often contains 30% blende, is free and in sheet-ground. Hand-flies make a good saving. The railroad centre of Quapaw is also busy. Conditions in the Miami district are flourishing.

UTAH

ALTA. The Alta Tunnel & Transportation Co.'s adit is in 2100 ft. Large ore bins are to be built at the portal. These are not needed at present, but should be within three months. At least three veins will be cut during the next 500 feet.

In American Fork Canyon the Earl Eagle company is advancing its adit 8 in. daily in hard blue limestone. The face is in 325 ft. A 200-hp. H. Ingersoll-Rand compressor and 25-hp. Fairbanks-Morse oil engine have been installed. The portal of the adit has an elevation of 5500 feet.

EMERY. Besides treating local lead-silver ore, the Utah Minerals Concentrating Co. is treating tungsten ore from sev-

eral places, notably from the Bylesby mine near Lovelock, Nevada. From June 22 to July 22 the plant treated 388 tons, and then to August 22, 542 tons of tungsten ore. The Nevada ore contains 2% WO₃, which is concentrated to 45 and 55%. Garnet interferes with good separation. The recovery is 80%.

SALT LAKE CITY. The Ohio Copper Co.'s property at Bingham was sold at a sheriff's sale for \$750,000 to E. H. Skyes of the firm of Sullivan & Cromwell, Wall street, New York.

TIXTIC. A 25-ton leaching plant costing \$25,000, to treat zinc ore of the Lower Mammoth is to be erected within three months. Development at 1500 ft. in the mine is opening a large shoot. J. C. Dick is manager.

WASHINGTON

CHEWELAH. The Admiral mine, near Valley, and Hecla copper-silver mine, near Chewelah, will be shipping ore within the next two months. Both are newly-developed.

REPUBLIC. Sale of the Republic Consolidated Mines Co.'s property here to the Day interests for \$143,000 is now confirmed. As the new owners have ample capital, it is expected that there will be a much-needed revival at Republic.

CANADA

BRITISH COLUMBIA

Dividends paid in this province during August were \$367,470, making \$2,043,246 for 8 months.

According to Oscar Lachmund, general manager of the British Columbia Copper Co., the main adit has verified diamond-drill work. The 9 by 10-ft. adit is in 1000 ft., and has cut ore. The smelter at Greenwood is kept busy on company and custom ores.

AINSWORTH. At the Florence silver-lead mine there are 70 men employed in construction and development. The hydro-electric power-plant is being erected. A building for the 250-ton mill is half complete. A Broderick-Bascom aerial tram, 1400 ft. long, is to be constructed. The mine contains 200,000 tons of ore.

TRAIL. The Consolidated smelter received 11,487 tons of ore from August 15 to 21, inclusive, a large gain over the previous week. The total for the year is 318,558 tons.

ONTARIO

CORALT. On the 330-ft. level of the Adanac the rich shoot opened at 280 ft. has been cut.—A 2-in. surface vein showing native silver has been uncovered at the Hudson Bay.—The shaft being sunk by joint arrangement between the Peoples and the Ophir, on the property of the former, has reached the diabase, and cross-cutting has been started on the 425-ft. level.

PORCUPINE. There is said to be a shortage of skilled labor at this centre.

A second ball-mill is now crushing ore at the Dome mill. This makes 70 stamps, 2 ball-mills, and 6 tube-mills at work.

YUKON

DAWSON. On August 17, the 20th anniversary of the discovery of gold in the district, the *Dawson Daily News* issued a special edition. Including the estimate of \$4,000,000 for 1916, the gold yield since 1885 totals \$190,000,000.

KOREA

On August 29 the Oriental Consolidated distributes 50c. per share.

MEXICO

HIDALGO

PACHUCA. During July the Santa Gertrudis made a profit of \$7200 from the treatment of 20,282 tons of ore.

More than 20 mining and metal corporations are to be represented by Institute members at the meeting of the A. I. M. E. that convenes in Arizona on September 18. Leading metal producers will have members of their staffs at the sessions, at which 70 papers on all subjects are to be discussed.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

MORTON WEBBER is in Arizona.

S. H. DOLBEAR is at Grants Pass, Oregon.

FORBES RICKARD is again at Lovelock, Nevada.

W. F. FERRIER is examining mines in British Columbia.

HORACE V. WINCHELL was recently at Lovelock, Nevada.

J. P. MONTAGUE, formerly at Tonopah and Manhattan, is at Butte.

H. A. B. MOTHERWELL is with the Arizona Copper Co. at Clifton.

G. T. HOLLOWAY, who has been in Norway, is on his way to Canada.

T. A. RICKARD returned from British Columbia on September 3.

RAYMOND BROOKS is in San Francisco on his return from Manitoba.

NELSON DICKERMAN has gone to Bolivia, expecting to return in December.

HOWARD D. SMITH has returned from London and is now in New York.

H. G. THIELE succeeds P. B. McDONALD as an assistant-editor on this paper.

C. S. WARD has returned to the Onondaga mine, Georgetown, Colorado.

F. W. OLDFIELD has returned to the Cinco Minas, Jalisco, by way of Mexico City.

R. GILMAN BROWN and D. P. MITCHELL have returned to London from Russia.

H. VINCENT WALLACE has been to Oatman, Arizona, and is now at Yellow Jacket, Idaho.

F. L. SIZER has gone to Montana. His temporary address will be at the Silver Bow club, Butte.

NORMAN C. STINES is to remain for another three years with his company at Polevskoj, Siberia.

W. PELLEW-HARREY passed through Vancouver on his way from London to Great Cobar, Australia.

R. B. BRINSMADE has been examining mines in the Metline and Washougal districts of Washington.

H. A. GUESS of the A. S. & R. Co. is on the directorate of the New York & Honduras Rosario company.

GEORGE E. STEPHENSON was at Vancouver last week on his way from London to Prince of Wales island.

B. L. THANE is to continue in active charge of the operations of the Alaska Gastineau Gold Mining Company.

AMASA P. PEAKE of the Western Mines Co., Woody, California, was here for a few days and has gone East.

P. G. MORGAN, director of the Geological Survey of New Zealand, has been appointed Under Secretary for Mines.

DONALD F. LEVIN is engaged in the investigation and establishment of the strontium nitrate industry at Los Angeles.

C. H. ABELING, recently with the Broadwater Mills Co. at Park City, Utah, is with the O. & N. Mines Co., Helena, Montana.

ALFRED H. BROOKS, who for 16 years has been in charge of the work of the U. S. Geological Survey in Alaska, recently paid his annual visit to Juneau.

MYRON A. FOLSON is now in charge of the commercial and legal departments of the Hunter Hill & S. River company, with headquarters in San Francisco.

THE METAL MARKET

METAL PRICES

San Francisco, September 5.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	28.75
Pig lead, cents per pound.....	6.75-8.00
Platinum: soft and hard metal, per ounce.....	\$80-\$84
Quicksilver: per flask of 75 lb.....	\$77
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

Platinum has jumped \$20 per oz. above last weeks' price.

ORE PRICES

San Francisco, September 5.

Antimony: 50% product, per unit (1½ or 20 lb.)....	\$1.00
Chromite: 50% and over, f.o.b. cars California, per ton.....	13.00-16.00
Manganese: 50% product, f.o.b. cars California, ton.....	12.00-16.00
Magnesite: crude, per ton.....	7.00
Tungsten: 60% WO ₃ per unit.....	14.00

EASTERN METAL MARKET

(By wire from New York.)

September 5.—Copper is strong and fairly active, spot metal being scarce; lead is dull and weak; spelter is stagnant and weak.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Aug. 30.....	67.25
" 31.....	67.25
Sept. 1.....	68.12
" 2.....	67.75
" 3 Sunday.....	66.43
" 4 Holiday.....	66.08
" 5.....	66.41
Sept. 5.....	67.67

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	Aug.	54.35
Feb.	57.53	48.45	56.74	Sept.	52.75
Mar.	58.91	50.61	57.89	Oct.	51.12
Apr.	58.52	50.25	56.37	Nov.	49.12
May	58.21	49.87	56.14	Dec.	49.27
June	56.13	49.63	55.94		

The silver market is strong, with a higher tendency. A big demand for coinage continues in England and Europe. India has been disposed to compete with the coinage orders. Exports from London to India up to August 16 totaled 1,687,500, against 13,975,250 in this period of last year. It is reported that China has parted with as much silver lately as could be spared; but metal is still arriving at Shanghai from the interior, and as long as this movement continues the rise in silver may be retarded.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Aug. 29.....	28.00
" 31.....	28.00
Sept. 1.....	28.00
" 2.....	28.00
" 3 Sunday.....	28.00
" 4 Holiday.....	28.00
" 5.....	28.00
Sept. 5.....	28.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.50	14.20	July	14.76
Feb.	14.16	14.38	16.62	Aug.	14.34
Mar.	14.11	14.80	16.65	Sept.	14.72
Apr.	14.19	16.64	18.92	Oct.	14.10
May	13.97	18.71	20.02	Nov.	14.75
June	13.60	19.75	20.47	Dec.	14.75

On September 30 the following dividends are payable: Chino, \$1 and \$1.25; Nevada Con., \$0.37½ and \$0.50; Ray, \$0.50 and \$0.25; and Utah Copper, \$1.00 and \$1.50 per share. United Verde is paying \$0.75 and \$0.75; Wolverine, \$0; and Utah-Apex, \$0.25 per share.

Estimates place the August output of Michigan mines at 23,000,000 pounds.

Arizona Copper Co. produced 4,400,000 lb. in July; Chino, 6,883,403 lb.; Nevada Con., 8,537,231 lb.; Ray, 6,834,492 lb.; and Utah Copper, 20,302,228 lb. Shannon's August yield was 925,000 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Aug. 30.....	6.70
" 31.....	6.67
Sept. 1.....	6.67
" 2.....	6.65
" 3 Sunday.....	
" 4 Holiday.....	
" 5.....	6.65
Sept. 5.....	6.67

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
Mar.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

On September 5 the Bunker Hill and Sullivan pays two dividends of \$81,750 each. This makes \$18,081,000 to date. St. Joseph Lead Co. pays 25 and 50c. per share on September 20.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Aug. 30.....	9.00
" 31.....	9.00
Sept. 1.....	8.87
" 2.....	8.75
" 3 Sunday.....	
" 4 Holiday.....	
" 5.....	8.75
Sept. 5.....	8.87

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.11	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mar.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	16.91	Nov.	5.01
June	4.81	22.20	12.85	Dec.	5.40

Butte & Superior pays \$1.25 and \$5 per share on September 30. Owing to sales of accumulated metal, the July profit of American Zinc was over \$900,000.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Aug. 22.....	72.00
Aug. 8.....	75.00	71.00
" 15.....	74.00	71.00
Sept. 5.....	71.00	71.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50
Feb.	39.00	60.00	235.00	Aug.	38.00
Mar.	38.00	78.00	219.00	Sept.	37.25
Apr.	38.00	77.50	141.60	Oct.	35.00
May	39.00	75.00	30.00	Nov.	55.00
June	38.60	90.00	74.70	Dec.	53.10

TIN

Prices in New York, in cents per pound.

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60
Feb.	39.76	37.23	42.60	Aug.	30.20
Mar.	38.10	48.76	50.50	Sept.	33.10
Apr.	36.10	48.25	34.19	Oct.	39.40
May	33.29	39.28	49.10	Nov.	33.51
June	30.72	40.26	42.97	Dec.	33.60

Tin is firm at 38.85 to 39.25 cents.

Eastern Metal Market

New York, August 29.

Business in copper is on a more moderate scale, but there is something doing all the time, and the basic condition of the metal is good.

Zinc declined again when consumers covered their requirements. In the past three weeks large quantities have been sold for export and domestic consumption, both prime Western and higher grades having been taken.

Lead is much less active, and the quotations of independents have dropped to the level of the A. S. & R. Co. Exports of lead are light.

The tin market has been quiet and presents little of interest, except that it is firm.

Antimony has turned dull again, and prices will recede unless demand develops, inasmuch as many holders are anxious to sell.

Aluminum is quiet, but firmer at 59 to 61c. per pound.

The steel trade is struggling to meet a demand that exceeds capacity, and prices of some products are stiffening again. In June and July there was a slight abatement of new business in some lines, but full pressure is on again. Steel is not offered today, it must be sought, and then cannot be had if early deliveries are wanted. Pig iron is becoming more active, a pleasing circumstance, especially with regard to foundry iron, the demand for which has been lagging for months despite the call for steel. Foundry grades would have been very active heretofore were it not for the scarcity of molders and other help. The machinery trade is enjoying a steady, healthy demand, although large lists are few.

COPPER

Business continues good, but it is on a more moderate scale. Spot metal is scarce and again is commanding a premium. The refineries are behind in their deliveries because of the recent heat and mechanical troubles. No strikes are reported. Prompt electrolytic is quoted at 28 to 28.50c., with last quarter around 27.25c., and first quarter at 26.50c. Lake, last quarter delivery, is about 27.50c. The metal is in a strong position, statistically and otherwise, and should there be a furtherance of the recent big demand prices will go up rapidly. Most of the late business has been handled by first-hands, dealers figuring but little. The London market was strong yesterday at £129, against £127 a week previous. Exports, August 1 to 29, totaled 27,635 tons. Sheet brass continues difficult to obtain for delivery this year. Customers of the largest producer are reported to be paying 37 to 38c. per lb., but others have to pay up to 40c. Sheet copper, also bars, are quoted at 37c. base, and heavy copper tubes at 41c. Smaller sizes, more in demand, are quoted at 46c. and upwards. A great quantity of brass and copper products have recently been purchased by J. P. Morgan & Co. for export to the Allies. In connection with the future of the copper market the following, appearing in 'Copper Gossip,' the house organ of the National Conduit & Cable Co., is interesting:

"Interests in control of the bulk of American output have maintained a significant degree of firmness lately. It was asserted recently by a representative of one of the dominant factors that the producers are in comfortable shape to the end of the year, without booking any further business. The condition may therefore be fairly used as an argument for sustained strength on the basis of the present copper market. If the foreign inquiries coming from Great Britain, France, Italy, Germany and other countries culminate in sales anywhere near the tonnages mentioned in connection with the feeders thrown out, the transactions will require tremendous shipments to meet all the demands."

ZINC

The market has a quieter tendency and prices are on the decline, but in the past three weeks a tremendous business has been done, both for export and domestic consumption. As was hoped, the brass mills became active and contracted for large tonnages of brass-mill special, while prime Western was active also, and some of the producers are filled to the end of the year. Prompt prime Western was quoted yesterday at 9 to 9.25c., New York, and 8.75 to 9c., St. Louis. Fourth quarter could be had at 8.50 to 8.75c., St. Louis. The producers think that the market is basically strong, although the feeling at London is that the market there will sag. Spot zinc was quoted at London yesterday at £58, against £55 a week previous. Exports to the 29th totaled 10,618 tons. At present domestic consumers are well supplied with metal. Complaint is heard that the recurrent weakness of the market is largely due to the failure of small producers to sit tight when demand eases off. If the market is still for a short time they become worried, and end by offering concessions to induce business. Sheet zinc in carload lots is unchanged at 15c. per lb., 87¢ off for cash.

LEAD

The heavy buying of a week or ten days ago has tapered off, and with the subsidence of business the quotations of independent producers have declined. The A. S. & R. Co. continues to quote 6.50c., New York, and 6.42½c., St. Louis. The outside producers have dropped their New York quotation to 6.50c. They ask the same price at St. Louis. A few days ago they were asking and getting 6.75c., New York, and one sale was reported at 6.80c., New York. For a time while the leading interest was quoting 6.50c. it was not selling at that figure; later it began to sell, but only to regular customers and then it fixed the quantities which were to be delivered. It knows pretty well what its customers require. The London market yesterday was £31 for spot, against £30 a week previous. Exports in 29 days were only 769 tons.

TIN

On the 24th and again on the 28th there were spurts of business, but not a great deal was done, and the week as a whole has been quiet. Spot Banca tin is still a factor in the market, but has not prevented the price of spot Straits from advancing a few points. It was quoted yesterday at 39.25c., with consumers showing but little interest. The arrivals of the month, up to yesterday, totaled 3617 tons, and there was afloat 2235 tons. The manifest of the German merchant submarine *Deutschland*, filed at the Baltimore, Maryland, Customs House, recorded that the vessel had taken in her cargo 181,049 lb. of tin; also 752,674 lb. of nickel. This metal, of course, must have been obtained by re-melting and recovery processes, inasmuch as no firm would dare to ignore England's regulations with regard to exportation of the metal.

ANTIMONY

The market is stagnant again, but the quotation of a week ago—13.50c.—still holds, although a search might find sellers willing to shade this price. Needle antimony is 10 to 10.50c.

Antimony ore: No business is reported, and none is likely with the refined metal so stagnant as it is at present. The last sales recorded were at \$1.10 to \$1.20 per unit.

Tungsten ore: The foreign demand continues, and about 200 tons has been taken for export. Foreign buyers want to buy below the market, otherwise more would be done. In the past week \$20 per unit has been paid by domestic consumers, and negotiations are pending for 100 tons around that figure, although down to \$18 has been quoted.

Industrial Notes

Information supplied by the manufacturers.

Portable and semi-portable air-compressors are described in Bulletin No. B5 of the ZIN-HO MANUFACTURING Co., of Chicago. Methods of driving are electric and gasoline.

The Intermountain Tungsten Milling Co. of Denver is remodeling the Black Cloud mill near Salina, Boulder county, and has given the DENVER QUARTZ MILL & CRUSHER Co., an order for one No. 2 Denver quartz-mill, 8 by 12-in. Denver crusher, and other equipment.

In its 180-page 'directory' the BURD HIGH COMPRESSION RING Co., of Rockford, Ill., gives a tabulation of the piston-ring requirements of almost every automobile of importance made in the United States during the past 10 years; also similar information on other internal-combustion engines.

At the Dome Lake mine, South Porcupine, Ontario, the residue is worth only 40c. per ton. The KOERING CYANIDING PROCESS Co. is highly pleased with the results of its system in this mill. Prior to installation of the cyanide plant the loss was \$1.83 per ton. The mill is now treating 80 tons daily.

Catalog No. 12 of the NATIONAL TANK & PIPE Co. of Portland, Oregon, describes its products, namely, standard water-tanks, patent water-tanks, plain and patent oil-tanks, closed oil-tanks, gravity tanks, storage-tanks, house tanks, half-round stock-tanks, joist foundations, wood and steel tank-towers, and tank-covers. Some useful tables complete the publication.

Polyphase induction-motors; type AA-7a air-compressor for air-brake equipment; type AC-3 air-compressor for air-brakes, stationary equipments, and portable equipments; and compressors for industrial purposes, are described and illustrated in Bulletins 1087A, 1525A, 1530A, and 1536 of the ALLIS-CHALMERS MANUFACTURING Co., Milwaukee, Wisconsin.

The Frontenac mill at Black Hawk, Colorado, has been purchased by the MORSE BROS. MACHINERY & SUPPLY Co., of Denver, who will dismantle it and move the material to Denver. The plant was of 250-ton capacity, consisting of crushers, rolls, tube-mill, Traylor jigs, Card and Heister tables, all electrically operated. The plant was built in 1912, and operated about 9 months. In purchasing the Colorado & Eastern line, 17 miles long, the firm has 185 tons of 60-lb., and 400 tons of 18-lb. rail for sale.

While centrifugal pumps have been a product of the PELTON WATER WHEEL Co. of San Francisco for a number of years, it is only after a careful study of their performances that the firm has decided to place these pumps on the general market. In Bulletin No. 9 the Pelton-Doble centrifugal is described. One of the unusual features is the uni-diffusion system of the volute. This results in high efficiencies. Another convenient characteristic is the over-hung pulley. The belt and direct-connected types of pumps are interchangeable.

The INGERSOLL-RAND Co. of New York recently issued three new bulletins as follows: (1) Form 9024 on steam-condensing plants—Beyer barometric type, described in this journal in the issue of August 5. (2) Form 4122 describing the IR model Leyner drill-sharpener. To those interested in properly formed and sharpened bits, this bulletin will be of timely interest, as it explains and illustrates the sharpener in detail and shows the various styles of bits. And (3) Form 3033 describing the Imperial 'NPV' duplex steam-driven compressors produced to meet a universal demand for a steam-driven air-compressor designed and constructed to operate satisfactorily under high pressures and superheat as well as under ordinary steam conditions.

Book Reviews

COAL MINERS' POCKET-BOOK. P. 1172. Ill., index. McGraw-Hill Book Co., New York, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$4.

This is the 11th edition, revised and enlarged, of what was formerly the 'Coal and Metal Miners' Pocket-Book.' In this edition matter dealing with mining of ore has been omitted, hence the change of title. But those connected with any class of underground work will find here a fund of information, such as mathematics, surveying, concreting, wire ropes, properties of materials, hydraulics, value of fuels, boilers, compressed air, electricity, explosives, timbering, haulage and hoisting, ventilation, and glossary of mining terms. The book is well arranged, printed on thin paper, is flexible, and should be found worth the price.

THE THEORY AND PRACTICE OF MODERN FRAMED STRUCTURES. By J. B. Johnson, C. W. Bryan, and F. E. Turneaure. Ninth edition, re-written by F. E. Turneaure and W. S. Kinne. Part III. Design. P. 479. Ill., index. John Wiley & Sons, Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$4.

The latest edition of this standard work has been re-written by one of the surviving authors in collaboration with W. S. Kinne. The general arrangement and the topics covered are, however, similar to the old work. The subject of columns has been treated at considerable length, both from the standpoint of experiment and of theory. Secondary stresses are considered with special reference to their influence upon design. The analysis of plate-girder stresses is unusually complete. The chapters on highway bridges, roof trusses, and mill construction are comparatively brief. The complete list of chapter headings is as follows: Styles of Structures, Working Conditions, Compression Members, Combined Direct and Bending Stresses, Riveted Joints, Plate Girders, Truss Bridges, Design of a Pin-Connected Railway-Bridge, Riveted Trusses, Design of a Riveted Highway-Bridge, and Steel Railway Bridges. The appendices contain general specifications for steel railway bridges, tables of standards, and a discussion of unsymmetrical bending.

HYDRAULIC FLOW REVIEWED. By Alfred A. Barnes. P. 152. Ill., index, and 11 plates. Spohn & Chamberlain, New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$4.50.

In Part I the author discusses the formulae of Chezy, Kutter, and Bazin for hydraulic flow and offers a new formula of the form $v = Kmab$, where K , a , and b are constants for each class of pipe or channel. It should be noted that m and i are the quantities more familiarly known to American engineers under the names r and s , and that K , of course, corresponds to c in the Chezy formula. The various kinds of pipes and channels are divided into 18 different classes, and values of K , a , and b given for each class. The last two quantities are less than unity in every case. Lists of several hundred experiments by different investigators for all conditions of hydraulic flow are given, the velocity actually measured agreeing with the velocity computed from the author's formulae within a few per cent in every case.

In Part II, the author in a similar manner derives simplified formulae for the discharge from triangular and rectangular weirs and circular orifices, comparing the results derived from the formulae with those actually obtained from experiment. The author has done a large amount of painstaking work, and those hydraulic engineers who are not completely wedded to the use of some of the accepted formulae, are in a position to profit from it.

EDITORIAL

T. A. RICKARD, Editor

THE industrial capacity of this country is sold in advance to the middle of 1917.

COST of living, according to *The Annalist*, has risen from 132 in September 1915 to 182.51 in September 1916. These figures represent index numbers of household commodities.

MEXICAN conditions are under review by the International Commission; meanwhile resumption of mining is in progress in several districts. We are glad to hear that the Dos Estrellas, Esperanza, and Mexico mining companies, at El Oro, are again at work.

TWO years ago the four principal banks of Europe, namely, those of England, France, Germany, and Russia, held \$680,000,000 more gold than was possessed in the United States; now the gold supply of this country is within \$50,000,000 of the combined holdings of the four great central banks of Europe.

REFINERY production of copper in August is estimated at 155,000,000 pounds, which is 35,000,000 less than in May. Slow deliveries of machinery and other equipment are said to be retarding smelter production, but by October a further increase of output is expected. At 150,000,000 per month, the annual production of the United States would be 1,800,000,000 pounds, as against 1,225,000,000 in 1913—a 50% increase.

IT is estimated that the extra \$50,000,000 to be paid to the train-men in wages, in accordance with the Adamson Act, will require an increase of 2½% in the freight revenue of the railroads. Last year the New York Central had an income of \$105,000,000 from freight charges; on an 8-hour basis the additional expense would be \$2,625,000 annually. None of these figures begin to reflect the damage done to the country by the bulldozing of Congress.

DURING the fiscal year ended June 30, exports of copper and manufactures had a total value of \$173,916,226, in comparison with \$99,558,030 in 1915. Brass exports totaled \$164,876,044, as against only \$20,544,559 during the previous year. The export of explosives increased from \$41,476,188 to \$467,081,928—a more than tenfold multiplication. Lead and its manufactures increased from \$9,044,479 to \$13,787,774. Machinery, from \$93,863,694 to \$182,677,065. Iron and steel products were exported to the amount of \$621,209,453, as compared with \$225,861,387 in 1915. Finally, zinc and

its manufactures contributed \$45,867,156 to our export trade, as against \$21,243,935 in the previous year. These are eloquent statistics.

AS we go to press, the evening paper announces the collapse of the bridge-structure across the St. Lawrence at Quebec. Apart from the loss of life and money, this is one of the greatest disasters in the history of engineering, because it follows a similar collapse of steel-work in 1907 at the same spot and in the same effort to bridge the St. Lawrence. The earlier disaster was made the subject of a novel, 'Web of Steel,' reviewed in our issue of April 22, 1916. The double event proves that the art of bridge-building is not based on exact science. It calls for a painstaking investigation.

FLOTATION is to be part of the regular practice in the silver mills of Cobalt, Ontario, the product to be treated being slime that has passed over concentrators and old tailing. At the McKinley-Darragh the residue now contains only 0.9 oz. silver per ton, after flotation. The Buffalo company is just completing a 600-ton plant. Other flotation units are being erected, one of 500 tons at the Nipissing, another of 100 tons at the Coniagas, another of 200 tons at the Dominion Reduction, and one of 100 tons at the Northern Customs plants. Beneficiation of the silver-cobalt-arsenic-nickel ores of this district will be considerably improved by flotation. The silver ore of Tonopah is much easier to treat by cyanide than that of Cobalt, and the question of freight on concentrate has to be considered in Nevada, so it is not likely that flotation will be applied there as largely as in Ontario.

RHODESIA made the mistake of adopting the apex law at about the time when most of us in this country had begun to wish it had never been introduced. Now the London courts are being treated to a lovely example of the interminable kind of dispute engendered by the extra-lateral doctrine. The suit, between the Amalgamated Properties and the Globe & Phoenix companies, was commenced last October and was continued for 122 days, until the end of July, when it came to an abrupt stop by reason of the illness of the defendant's leading counsel. His illness is not surprising, seeing that he had been speaking for 23 days before his strength failed; he asked for an adjournment in order that he might recuperate his energies, but the plaintiff objected; eventually the Judge decided that part of the summer holiday must be sacrificed and the hearing was resumed on August 21. The problem before the court is the old one as to the

identity of veins: whether there are several formed at different periods or only one with branching veins. The discussion is proceeding. The point at issue will be decided on scientific grounds at the Greek kalends.

ON September 18, and the remainder of that week, the American Institute of Mining Engineers will hold a meeting in Arizona, the various sessions being distributed among the towns of Douglas, Bisbee, Globe, and Phoenix. Preliminary announcements indicate that the chief metal-producing districts will be visited, besides other points of interest. This is the first time the Institute has held a meeting in Arizona and it is expected that the attendance will be large. At Douglas the technical discussion will be devoted to smelting; at Bisbee to mining geology; at Globe, one day to mining and smelting, another to leaching, and a third to flotation. Advance-sheets of the papers to be presented at these sessions indicate the probably unusual interest of the discussions to be elicited. The committee in charge of local entertainment is headed by Mr. Gerald F. G. Sherman, aided by Mr. Arthur Notman as secretary.

DISCUSSION begins this week with a letter from Mr. J. R. Finlay, replying to our editorial comment on the views expressed by him in a recent address before the Colorado School of Mines. We are glad that Mr. Finlay should have submitted a rebuttal, for we feel sure that our readers will find it interesting. Next, Mr. F. F. Sharpless, a mining engineer of distinction, writes from New York to comment upon the suggestion made recently by Mr. Harold French, who suggested a scheme for prospecting. The objections raised by Mr. Sharpless are reasonable and serve to illustrate further the great difficulty of organizing exploratory work. The account of the procedure adopted by a particular organization and the results of it are much to the point. In regard to selection of books suitable for use by the nomadic members of our profession, we publish suggestions from Messrs. Claude Ferguson and Arden Proctor. We shall be glad to hear from others. Mr. W. R. Sherman suggests a simple code for signalling. Mr. A. B. Peckham, who wrote the original article on cyanidation at the Comaezan mine, in Salvador, replies to Mr. C. O'Brien's criticisms. The C. C. D. system does not lend itself readily to discussion, but we hope that this fact will have impressed itself less on the readers than it has upon the contributors to this department of our paper.

Flotation Royalties

On another page we publish verbatim the agreement made between the Minerals Separation Limited and two great copper-mining companies, the Anaconda and Inspiration. This agreement and another, made previously with the Anaconda company, were included in the evidence taken in the Minerals Separation v. Miami suit tried at Wilmington last year; they formed part of the

court record and are therefore public; we simply obtained a copy as anybody is entitled to do. And we did this because these contracts are likely to serve as a measure of the damage to be claimed by Minerals Separation in case this company's patents are upheld. As the number of those disregarding the patents, under the belief that they are invalid, is at least as large as the number of those licensed by Minerals Separation, it is likely that this contract will be studied with interest by many of our readers. Out of the 25,000,000 tons of ore now being treated by flotation in the United States, we estimate that fully one-half pays no royalty and expects to pay none. Accurate statistics of tonnage are not available, for obvious reasons. The chief alleged infringers are the Jackling group of copper companies, the Miami, the Butte & Superior, and the operators in the Coeur d'Alene. To them the decisions in the two pending suits will prove important. The more important, the Supreme Court decision in the Hyde case, is expected in November, while the pronouncement in the Miami case by the first-trial court at Wilmington is due during the current month. Hence the question of royalty is pertinent. The unprejudiced reader will agree with us, we believe, that the royalty charged to the Anaconda and Inspiration companies is not excessive; it ranges from 12 to 4 cents per ton of ore treated, in proportion to the tonnage. At the present time these companies are treating an aggregate tonnage of fully 30,000 per day. According to the terms of the agreement they would be paying 9 cents per ton on the first 10,000 tons; they would be free of royalties on the next 5000 tons, up to 15,000; they would pay 8 cents on the next 15,000 tons, so that the average would be 7 cents per ton on the 30,000 tons treated. Taking a royalty of 12 cents on a 1% ore, containing 20 pounds of copper at 20 cents, for example, the rate is 12 cents per \$4, or 3%. On a 2% ore, it would be 1½%. This assuredly is not an excessive tax, provided the Minerals Separation represents the real inventors of the process, as to which we should venture to express a pious doubt even after the Supreme Court had decided otherwise, having read the record ourselves. In the Anaconda agreement the royalty is specified up to any tonnage above 6000; evidently the rapid extension of the process led to the making of the later and more comprehensive contract that we publish. Of course, on these big tonnages the Minerals Separation company gathers a lordly income; 7 cents per ton on 30,000 tons daily represents about \$750,000 per annum. A royalty of 10 cents on the 25,000,000 tons being treated in this country alone would represent \$2,500,000 per annum. Evidently the fight over the patents involves a great deal more than a scientific principle. Moreover, the patent-owning company is claiming royalty not only on the ore treated in the flotation machine but on all the ore that enters a mill in which the process is used; they have claimed it on ore removed on a picking-belt and on jigs or tables previous to frothing. Another factor prejudicial to the welfare of the mining industry and irritating to the licensees of

Minerals Separation is the clause, appearing in the Anaconda contract, whereby any improvements or discoveries made by the licensees shall be made known to the licensors, to be patented on their account by them. The licensors agree to give "all assistance, information, and advice in their power as to the working of any of the said inventions," but it has been the experience of several licensees, as they have informed us, that once a contract has been signed the interest of the licensors in aiding their clients has decreased rapidly. Moreover, in several cases, the original plant and mode of operating introduced by Minerals Separation have been discarded in favor of better methods or more efficient machines devised by the licensees, who are still under legal compulsion to pay royalty. Again, the licensees are not permitted to "communicate any detail connected with the working of any of the said inventions to any third party not being a licensee." To this the sheaf of informing papers presented at the Arizona meeting of the Institute by engineers in the service of the Inspiration and other licensed companies is a sufficient reply. Finally, we remind our readers of the illegal contract forced by Minerals Separation upon metallurgists in the employ of licensees, as made clear in our issue of February 5, 1916. All these efforts to place an embargo on the spread of knowledge and the publication of technical information have failed, and we are proud of having contributed to the failure. The flotation process invented by Elmore and modified by Froment was developed mainly on Australian practice, but the process as used today in the United States has been developed during the last three years by American metallurgists most of whom were, and are, outside the employ of Minerals Separation. We sympathize with the good feeling of those in technical control of the operations at the Inspiration and Anaconda mines in their willingness to recognize the good work done by the Minerals Separation people and their appreciation of the help given in treating a low-grade product profitably, but we have no less sympathy with the numerous operators that have had the muzzle of a peremptory contract leveled at them, with sundry preposterous clauses, in a spirit so overbearing as to provoke instant opposition. Such powerful companies as the Anaconda and Inspiration have made terms by no means onerous, as will be seen, but the smaller operator has had to pay a larger royalty, up to 25 cents per ton, and, what is worse, to tie himself by conditions stultifying to himself and to his staff. On gold ores the royalty is usually 25 cents per ounce, or 1 1/4%. This also is small, provided the patents owned by Minerals Separation cover the basic invention. But again we say that the question of royalty would have raised no antagonism if the attempt to enforce it had not been accompanied by other demands, some of them illegal and others only irritating. The fat is in the fire; the so-called infringers are led by a group of rich and resourceful men; it is quite certain that no compromise is now possible and that the fight is to a finish.

Decomposition of Cyanide

Mill-men are familiar with the odor of hydrocyanic acid gas in a cyanide plant, particularly in damp weather, but few have troubled to investigate the cause of it. By the dissolving of precious metals in cyanide solution and their subsequent precipitation, most of the cyanide is lost, that is, a weak solution is made up to working strength by adding cyanide salt, but during the cycle of operations the solution returns to its original weak point, therefore the salt added is consumed. Chemical and mechanical causes account for losses of cyanide, the principal ones being reactions with the ore, atmospheric decomposition, waste in residue, and leakage from tanks. These losses are not the same in any two mills, even on similar ores. Cyanicides in ore and water are always present, and usually they can be checked, but not without constant attention. Mechanical losses should be reduced to a minimum without much trouble. The average metallurgist knows that air plays an important part in cyanidation, also that it causes decomposition of the solution, but he has been content to assume that this was unavoidable. And his conclusion is not far wrong. On another page of this issue we publish the results of a thorough investigation into this matter made by Messrs. G. H. Clevenger and Harry Morgan at Stanford University. In 1909 the former observed that when a plant was treating below its capacity, consumption of cyanide per ton of ore was greater than when working at full capacity, although the quantity of solution in circulation was similar for both tonnages, giving the air equal scope for action. Laboratory tests made at a plant in Central America showed that after 216 hours' exposure to the mill atmosphere only a trace of KCN remained. Several kinds of cyanide with different solutions were tried, confirming previous tests, although there was less decomposition in the mill-solutions than in those from fresh cyanide to which no protective alkali had been added. Light has practically no effect on the decomposition of solutions, as was proved by exposure for 192 hours in light and dark stoppered bottles. In 1912, Mr. A. J. Clark made a similar test at the Homestake, showing substantially the same decomposition. Julian and Smart, Thorp, Clennell, and Watt have discussed atmospheric action on cyanide in their books. While studying these reactions, Messrs. Clevenger and Morgan found it necessary to determine cyanide, cyanate, hydrate, carbonate, ammonia, and formate in cyanide solutions. This work necessitated careful research. Next they exposed solutions of a particular strength to the air in 5 1/2-inch beakers. In two series of tests when no alkali was added, a steady loss of cyanide was observed; but where alkalinity was kept constant the rate of decomposition was lowered, but never so low as without alkali. A study was made of the gaseous products of atmospheric decomposition of solutions, with the discovery that most of the reaction involves the formation of HCN. Other products are an alkaline carbonate and ammonia. In addition to

atmospheric action, there is the decomposition known as hydrolysis, having the equation



This proceeds until equilibrium is established for the particular concentration of cyanide in solution. A mill-solution that contains no protective alkalinity may lose some of the HCN through normal hydrolysis, but if sufficient air be brought into contact with the solution a large part of the cyanide may be lost through progressive hydrolysis. Hydrolysis may be defined as the chemical decomposition of a compound that ensues when the group H_2O is absorbed by it, causing the formation of new compounds. Cyanide plants that operate with a low alkalinity run the risk of losing cyanide owing to the accumulation of the soluble alkaline carbonate, K_2CO_3 , which does not afford protection against the CO_2 of the air when the real protective alkalinity (lime) has disappeared.

In another part of their paper, the authors discuss investigations on the Rand during 1915, an abstract of which was published in this journal under date of January 8, 1916. In treating 25,701,954 tons of ore, there was consumed an average of 0.4 pounds per ton. A number of tests on typical sand and slime showed that the loss of cyanide, due to the escape of HCN as gas into the air, was from 44.7 to 49.5%. Loose or incomplete covering on sump-solution tanks did not suffice to prevent loss of alkali or cyanide. In weak solutions there is no loss of HCN as total cyanide, and but little loss as free cyanide, so long as a protective alkali is present. When the protective alkalinity is below 0.01% NaOH, the loss of HCN as free and total cyanide becomes serious. The presence of zinc considerably decreases the loss of HCN by hydrolysis. Another investigation covered the exposure of working solutions to the atmosphere under varying conditions. While transferring solutions from slime treatment vats at one plant, as much as 0.14 pounds of sodium cyanide per ton of slime disappeared by evaporation of HCN. It was concluded that the loss is greater in pure synthetic solutions, when making tests, even with added alkali, than is the case with ordinary working solutions, and a heavy loss is shown in the presence of little or no protective alkali, when determined with additions of ferro-cyanide. By fitting tight covers to treatment-vats and solution-tanks a saving of 0.09 pounds per ton of ore might be effected. Regarding hydrolysis, it was ascertained that simple solutions decompose by this action; higher temperatures accelerate this decomposition; the alkali formed as a product of hydrolytic action has little or no protective effect on the remaining cyanide, so that hydrolysis proceeds until all the cyanide is destroyed; and that the protection afforded by adding an excess of caustic alkali is only of temporary value. Messrs. Clevenger and Morgan attacked the problem in the same general way as the African metallurgists, but completed most of their tests before the latter began. Generally our authors agree with them, but are not in accord concerning the protective alkali. Whether atmospheric decomposition of

cyanide is worth the study of mill operators is answered by concluding that (1) it may become a serious factor with solutions containing little or no protective alkalinity, (2) the cyanide lost through reactions with oxygen cannot be economically recovered, and (3) the most effective method of preventing decomposition is to maintain a sufficiently high concentration of alkaline hydroxides in the solution.

Australian Spelter

In our last issue we published an interesting letter from our London correspondent, commenting upon the future of the zinc-smelting industry in its world-wide aspect and referring to the recent purchase by the British government of 100,000 tons of concentrate from the Zinc Corporation on the basis of £25 per ton for the metal. This shipment of 100,000 tons is to be distributed among the smelting plants in Great Britain, their total capacity being about that much per annum, as compared with 60,000 tons before the War. In previous issues we have referred to the Australian zinc problem, that is, the question of treating the 500,000 tons of zinc concentrate produced at Broken Hill. Formerly this product was smelted in Belgium and Germany. There has been much talk concerning the building of new smelters in Great Britain, which consumes annually 200,000 tons of spelter, or just about as much as Australia produces, but nothing has been done toward the erection of any big plant because pre-existing contracts and other obstacles intervened. As stated in our Metal Market Review recently, the British government has agreed to purchase 100,000 tons of concentrate per annum during the War, and for ten years after the War. Moreover, the same government will purchase, annually for 10 years, 45,000 tons of spelter produced in Australia, this being the equivalent of 112,500 tons of concentrate per annum on an average assay of 40% zinc, besides 6% lead, and 9 ounces of silver per ton. Thus 212,500 tons of concentrate is marketed. Altogether, adding the tonnage already under contract in Australia, not less than 250,000 tons per annum is sold. Negotiations are pending for the sale of the remaining half of the output to France and Belgium. A sum of \$125,000,000 is involved in this deal between the British government and the Australian mining companies. The transaction is due to the initiative of Mr. W. M. Hughes, the Federal premier, and to Mr. W. S. Robinson, a distinguished director of mining companies in London. Finally, it is announced that the Imperial government has arranged to advance \$2,500,000 toward the cost of erecting the necessary smelting plant in Australia. While these plans go far to solve the Australian zinc problem, they do not settle it conclusively, for fully half the output of concentrate remains in the air, so to speak. However, this recent development will interest zinc producers in this country for many reasons, one being the lessening chance of our own domestic market being flooded with Australian ore.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

The Imponderables

The Editor:

Sir—While I have no objection whatever to your editorial on my address, I am not altogether pleased at giving the impression of being a worshipper of the output of coal and iron.

It seems to me the great imponderable is *mens sana in corpore sano*. This includes everything, even greatness of soul. It is no simple thing, but a marvelously subtle and complex aggregate of balanced qualities—not an exaggeration of any virtue. Even greatness of soul may be exaggerated into a stupid vice. We look upon the Hindoo ascetic who vows to show his fortitude to God and man by holding his hand over his head until his arm withers and becomes useless, as a mere travesty of a man. The healthy minded Anglo-Saxon thinks that he will do better to use both his hands as well as his head and that God will love him just as well if he exerts himself to be comfortable as if he exerts himself to be miserable. At any rate he exerts himself.

I think one of the manifestations of his mental and bodily vigor is his success in industry. To say that this success is obtained at the expense of losing out in other directions is to my mind absurd. The illustrations you use to point toward the great mental impulses that come from non-industrial peoples do not prove your case, but the contrary. For instance: You say that the Hebrew race was denied industrial participation. Was it? Were not the Jews a part of the Semitic race, which held for many centuries the industrial and commercial leadership of the Mediterranean? Are not the Jews of today as well known for their materialism as for their idealism and do not they produce in every country high examples of both?

The age of Pericles was the age of the industrial and military supremacy of the Greeks. In the days of Virgil, Italy was the political, industrial, and military leader of the world. The same England that produced Shakespeare, produced at the same time Queen Elizabeth and Sir Frances Drake. In the same country Tennyson was the contemporary of Bessemer, and Byron was a contemporary of Watt. Your Oxford is a suburb of the industrial centre of the world; Huxley lectured in the heart of London; and the people of Boston, much as they might value your compliment to Harvard's intellectual prowess, would be likely to remind you that Cambridge is in the heart of a great industrial centre. The same Germany that produced Goethe also produced the Krupps. I have no doubt that Russia having produced

its Tolstoi will come along with some industrial genius.

When Van Dyck and Rembrandt painted in Holland, that country was the leader in trade. Louis XIV was the patron of Moliere. Your argonauts of California brought with them Bret Harte and Mark Twain, and Homer sang of the explorer Odysseus. The country that produced Lincoln and Julia Ward Howe had at the same time Rockefeller and Armour. The country of John Knox is that of Carnegie.

You say the type of man who runs a steam-shovel "is more likely to read the tape than to read Shakespeare." Well let us get down to that: Who reads Shakespeare? Speak it gently: It is the hustling German!

J. R. FINLAY.

New York, August 22.

Prospecting

The Editor:

Sir—Suggestions as to a practical manner of prospecting are always interesting, but I fear that some of the uninitiated, who were addressed in the communication of Mr. Harold French, in your issue of July 22, would be disappointed should they attempt to follow his suggestions too closely.

In the first place I am not at all sure that you are wise in giving space to suggestions that are made for the benefit of those who are thinking of "taking a chance," that is, our citizens who are but slightly interested in mining—the average banker, broker, merchant, tradesman, or small capitalist. Such men are not reading technical journals relating to mining and the papers they do read do not care for that kind of copy. Your readers are largely men with a little or with considerable knowledge of mining and generally have their own conception of the proper method of conducting prospecting operations and I fear will not give very serious consideration to theoretical suggestions as to the best way in which to spend small sums for that purpose. Being one of this class myself and, as noted above, interested in the subject, I would appreciate an opportunity to read of successful prospecting enterprises, the method of financing, the manner of working, what was done, what was found, and what was done with the find.

I have had some years of experience in this line of work but I was never so fortunate as to find and develop 150,000 tons of \$8 ore with \$5000 as in the supposed case of Mr. French, and while not denying the possibility of such attainment, I doubt its frequent occurrence.

There are several practical difficulties in the way of such an attractive undertaking. The employment of a "mining engineer who is qualified to conduct a geological survey and to direct the efforts of prospecting parties," at a salary of \$250 per month for the month of June, with the possibility of the work being discontinued or extended over another month or two, will be a hard order to execute. The summer months are the busy days for such independent engineers as could take such short engagements and except in rare instances of temporary unemployment, they are not available at such figures. No more are "skilled assistants" easy to find at \$100 per month.

Again, three miners and three muckers "driving several hundred feet of tunnels, sinking shafts, and making cross-cuts" thus demonstrating 150,000 tons of \$8 ore, would not only have to be very capable men but would have to be provided with something better than candles or carbide. Aladdin's own lamp would certainly have to be a part of the outfit.

Having asked for the methods of other operators in prospecting or exploring, it may be pertinent to mention the methods of procedure followed by one or more of the organizations with which I have been connected. An organization that had been operating successfully for several years desired to secure some new business. Their consulting engineer selected a man to scout for them. This man was a technical graduate, had been an assistant in a number of examinations, and had spent three years in subordinate positions in mines and mills. He was not a trained geologist, experienced mining engineer, nor a high class metallurgist. He was a bright intelligent graduate with quite a varied practical experience, and was worth about \$250 per month, and that was what he was paid on engagement by the year. There was nothing in the contract in relation to participation, but from the action of the directors in previous instances, it was pretty well understood that if he brought any good business to them it would be to his material advantage. He was sent scouting in districts named by the directors. Broadly speaking, he was instructed to look for new business, but more particularly for things of prospective value that possessed indications of developing into something of importance.

It was found that this man's expenses amounted to approximately \$10 per day while away from the home office, or the total expense, salary included, amounted to about \$6000 per annum; this included his traveling, the employment of a few helpers from time to time to assist in sampling or digging prospect-holes, assaying, some local legal expense and, in fact, everything connected with the scouting.

The practical result in three years of this work was that about \$5000 additional was spent on prospects that developed nothing, his principals became interested as minority stockholders in three producing mines which he had brought to their attention. One very promising prospect was taken up on which \$10,000 was spent, by a newly organized and subsidiary company.

The location of this prospect and its cropping was such that a complete sampling of the surface over a width of 20 ft. and length of 1500 ft. was possible, also five cross-cuts were pushed into the vein at an average depth of about 50 ft. from the surface, and short drifts were run at the intersection, thus giving a very fair indication of what values to expect in the 100,000 tons of ore nearest the surface.

About 1000 ft. of cross-cuts and drifts were run, about four months' time was consumed, a little less than \$10,000 was expended, the value of 100,000 tons was indicated,* but not proved. Conditions for cheap prospecting were exceptional, the expense of driving and cross-cutting in rather hard, tough material, scarcely reaching \$5 per foot, the other \$5000 being used in sundry overhead and traveling expenses incidental to this operation.

The foregoing, from an actual experience, was far less profitable than the hypothetical case of Mr. French, but is probably much closer to what might be expected in practice. It was, however, sufficiently profitable to warrant the organization continuing the practice over a gradually broadening field, resulting in the acquisition of five prospects that have developed into mines as well as the acquisition of control or minority interests in a number of operating or more fully developed properties.

F. F. SHARPLESS.

New York, August 6.

A Traveler's Library

The Editor:

Sir—Referring to the communication of 'Subscriber' in your issue of August 12, the following observation concerning books suitable for a traveler's library may prove of value. It is my experience that such books should not be printed on coated paper. A library, especially that of an engineer, is at times subject to hard usage, such as a book printed on coated paper will not withstand. If such a book should get wet, unless the accident is discovered immediately and pieces of blotting paper placed between the leaves, the book is ruined. In camp, 'forty miles from nowhere,' this is not always an easy thing to do. I had my Hoover's 'Concentrating Ores by Flotation' ruined in this manner. This was a beautiful book printed on a fine grade of coated paper. It received a thorough soaking, and when I got a chance to examine it, some days later, I found it to consist of a solid block of paper pulp, neatly bound in cloth. Several other books which I had with me at the time were similarly wet, but, being printed on ordinary uncoated paper, suffered little damage in comparison.

I believe the thin bible paper (India paper), now almost universally used in our various engineers' pocket-books, to be the ideal paper for books for the traveler and

*When this ore was mined and milled two or three years later, it was found that the indicated value and tonnage, or probable ore, checked very closely with the quantity and value of that mined from the area of the vein considered.

engineer. It is light and strong, and the pages will not stick together on being wet. About everything has happened to my Trautwine that could to a book without completely destroying it, and it is still 'doing business at the same old stand.'

CLAUDE FERGUSON.

Mayer, Arizona, August 20.

The Editor:

Sir—A subscriber in San Salvador, asks in your August 12 issue for a portable library. The following list, though rudimentary, may start him on the right track as far as economy of space and weight are concerned:

Tracy's 'Plane Surveying.'

Trumbull's 'Underground Surveying.'

'Electrical Engineer's Handbook,' McGraw-Hill.

Croft's 'American Electrician's Handbook.'

Trautwine's 'C. E. Handbook.'

Spurr's (leather) 'Geology Applied to Mining.'

Miller's 'Prospector's Companion.'

ARDEN PROCTOR.

Englewood, N. J., August 31.

Signal Code for Surveying

The Editor:

Sir—During my experience as a field engineer and surveyor I have been surprised at the fact that there seems to be no simple and efficient wig-wag code in common use among engineers. There is, it is true, a generally recognized code of signals for the more common operations in the field, but a more elaborate system, which would cover any point which might arise, would result in the saving of much traveling and unnecessary work.

The wireless telephone is still out of the question, and the army and navy codes, while efficient, are too complicated. I have, therefore, devised a code, which, while comparatively slow, is efficient and may be learned in two hours practice at short distance.

In the starting position both hands rest on the breast and after each signal return to the same position. The different signals, corresponding to the illustrations, are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, and are self explanatory. For the alphabet the numbers corresponding to the alphabetic positions of the letters are given; that is A-1, T-20, Z-26, etc. The letters are separated by a dip and the words by a rise, both of which are shown. The dip and rise also indicate that letters, and not numbers are being given. The signals are shown in the accompanying illustration, commencing with 1 at the left, the positions from start, rise, and dip being on the right.

Convenient practice may be had by two persons standing at opposite ends of a room and sending any copy, such as columns of figures, that may be at hand.

W. R. SHERMAN.

Newman, California, August 16.

Cyanidation at the Comacaran Mine, Salvador

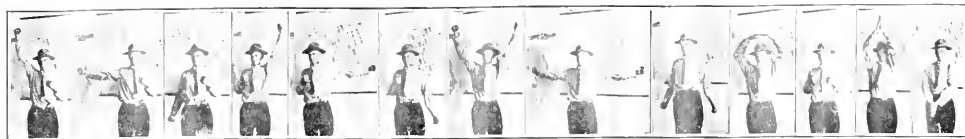
The Editor:

Sir—In reading Mr. C. O'Brien's criticism in the issue of July 1, I felt that it called for an answer. In his zeal to defend what he styles a C. C. D. system Mr. O'Brien makes statements that call for discussion. I am just as strong an exponent of the continuous counter-current decantation process as he is, but there is no machine or process that is faultless.

In the first paragraph of the criticism the question is asked why the tube-mills are by-passed. "why something is coming out and nothing is going in." The reply is that the arrow-head on the dotted line connecting the figure representing the tube-mills with that showing the Dorr duplex classifier was missed in the drawing. The capacity of the agitators is 120 tons each. The gravity sample of each slime-charge is screened, and only 5% of minus 80-mesh stays on 200-mesh. The brevity of my article did not permit giving the screen-tests and analyses asked for.

I must apologize for the annoyance the misuse of the word "insoluble" has caused Mr. O'Brien.

In the fourth paragraph of his article he desires to know the reason for the "juggling" of the solutions. This was necessary, as after a thorough trial of the straight C. C. D. system, it was found to be insufficient with the number of thickeners we had, and we were forced to use barren solution also. A glance at the Comacaran flow-sheet will show that thickeners 5, 6, and 7 are in a real counter-current system. Between 4 and 5 the system is changed. The overflow of 5, which assays 50c. per ton, goes to the battery solution-tank instead of to 4, whose pulp is diluted with the overflow from thickener 1, which assays \$1 per ton. The reason for this change is, that the dilution carried on in thickener 5 is so great that if the overflow were used in thickener 4 the zinc-box heads would be impoverished too much. Furthermore, this disposal of the overflow of 5 makes it possible to reduce the dissolved metal in the pulp from the thickener that precedes it, over two-thirds, while each of the thickeners in the real C. C. D. system reduces the dissolved value in the pulp from the thickener that



SIGNALS FOR SURVEYING.

precedes it only a half, due to the dependency of these thickeners on the capacity of the pumps and piping. These are the reasons for the juggling of the solutions.

Mr. O'Brien's exception to what I called a battery solution is well taken. The overflow of thickener 1 is not only the battery solution, but the solution from the closed grinding-circuit as well. But on looking at the flow-sheet and reading the paragraph entitled 'Tube-Milling and Classification,' it will be seen that a 30c. battery solution is fed to the stamps that crush to 3-mesh. The pulp from the batteries goes directly to the Dorr duplex classifier. I have not the assay-value of the solution coming from the stamps, but considering the size of the screens and the short time that the ore is in the mortar, it can be seen that the solution can be enriched little above its original 30c., and that this solution mixing with the much smaller quantity of solution from the closed grinding-circuit dilutes the latter and gives the \$1 overflow from thickener No. 1. So the grinding-circuit is safe from the ignominious fate of "dying of ennui."

In paragraph eight Mr. O'Brien at last finds something worthy of praise in a tailing-loss of 10c. in dissolved metal. The 0.8 lb. of cyanide lost in the tailing cannot be accredited to the C. C. D. system. It is one of the disadvantages of the use of barren solution. The loss in cyanide and dissolved metal in the tailing is now being recovered by the use of Oliver filters.

It cannot be said that the sticking of the thickeners at the Comacaran mill was due to abuse. The chief reason was that the bottoms were too flat for the density of the underflow sought. The rakes can handle only the small quantity of non-mobile material that forms on the bottom, as the slope of the bottom should be sufficient so that everything fluid enough to flow towards the centre can do so. It is obvious that a pulp containing but 25% of solid will not need as steep a slope as a pulp containing 60%. One of the home-made thickeners at the Comacaran has a bottom slope of 17° and will easily give an underflow containing 50% solid. The only time this thickener stuck was when a peon dropped a shovel into it. Another unavoidable source of sticking was due to hard material caving from the sides and from the spider supporting the rakes.

In paragraph ten of his article my critic makes the statement that the use of barren solution is unnecessary. The manner of reducing the value in intermittent or continuous decantation is one of pure dilution. If the overflow were used exclusively it would take twice or three times as many thickeners, for the simple reason that the dilution would be carried on with solution containing from 10c. to \$1 per ton. In other words, to save some 200 tons of "unnecessary" barren solution we would have to lock-up continually several hundred tons of low-grade solution. The barren solution used on the sand-vats was not accredited to the C. C. D. process.

I would like to ask my friend what the grinding-circuit has to do with the extraction of metals from the treated pulp. If the heads are doubled, the dissolved

value in the treated pulp will be doubled, if the grinding-circuit is not dying of ennui. Therefore the dilution in the thickeners will have to be doubled or else the dissolved metals in the tailing will be doubled.

A rather bold statement is made when Mr. O'Brien says that "neither crushing nor re-grinding takes place in the last four feet of a tube-mill." A tube-mill will grind its entire length. Of course, the grinding toward the discharge-end will not be nearly as great as it is near the feed-end. The reason for this is that as the ore becomes more comminuted on its way to the discharge a sludge is formed along the central axis that serves to cushion the blows of the pebbles. This is why it has been found that a 16-ft. tube-mill grinds more per horsepower than a 20-ft. mill, with a smaller pebble consumption. This sludge could be eliminated by making the last four feet of a 20-ft. tube a cone, and in this manner getting the grinding capacity of a 16-ft. tube with the rapid discharge of a Hardinge mill.

In closing permit me to say a few words in regard to the statement that "any American machinery is as good as Krupp machinery." I object to the word "any." The best American machinery is as good as the best of any land, but the American manufacturer should not think that Latin-American orders are opportunities to dump defective or inferior goods. They should bear in mind that representatives of foreign houses are in the countries, and ready to guarantee prompt and safe delivery of first-class goods at reasonable prices. Imagine our waiting for months for tube-mill lining from an American firm and then receiving lining from which must be cut an inch from each segment before it can be fitted. Imagine waiting a couple of months for a gasoline engine and receiving it with the cooling hopper broken, due to defective packing, and the induction-coil and batteries removed from their box. In the last case it was necessary to send to the States for an induction coil. The trouble seems to be that the American manufacturer has all the market he needs at home. Not until the domestic market becomes over-supplied, and the American manufacturer is forced to build-up a foreign trade or go bankrupt will he put the energy and brains into his foreign trade that the Europeans have put into theirs. In the meantime the American metallurgist in foreign lands will be forced into the apparently unpatriotic necessity of putting foreign-made machinery in American-owned mines and mills.

A. B. PECKHAM.

Quartz, California, August 8.

GOLD AND SILVER received at the San Francisco mint during August are reported as 365,087.75 oz. and 190,727.17 oz., respectively. Bars of fine gold, valued at \$4,191,916.21, were sold. Coinage amounted to \$620,000 in half eagles and \$27,000 in nickels; also \$17,000 in one and five centavo pieces for the Philippines. The vaults contain coin, bullion, etc., valued at \$378,767,597.52.

Atmospheric Decomposition of Cyanide Solutions

By G. H. Clevenger and Harry Morgan

INTRODUCTION. The losses of cyanide occurring during the treatment of gold and silver ores by the cyanide process may be classified as follows:

Chemical Losses:

1. Reactions with various constituents of the ore, including those introduced during its preparation for treatment.

2. Atmospheric decomposition through contact with the air, including hydrolysis.

3. Impurities in the water used.

4. Reactions occurring during precipitation.

5. Certain equipment of the plant with which the solutions may come in contact.

Mechanical Losses:

1. Admixture of solution with residues.

2. Leakage of tanks or other containers.

3. Excess solution sent to waste.

The relative importance of these various sources of loss varies considerably, depending upon the character of the ore treated, the plant, and the manner in which it is operated.

Atmospheric decomposition of dilute solutions has not been generally recognized as an important source of cyanide loss; therefore, practically nothing is known regarding its magnitude or the reactions involved. One of us (Clevenger) in 1909, while investigating the treatment of a certain Central American silver-gold ore, had his attention called to the possibility of the importance of such losses through observing that the cyanide consumption per ton of ore was greater when the mill was treating a small tonnage than when treating its maximum tonnage, the extraction of gold and silver in both cases being approximately the same. In seeking for the cause of this greater consumption, the most reasonable explanation appeared to be that, inasmuch as the tonnage of solution in circulation and in stock in each case remained the same, in treating the smaller tonnage of ore a relatively greater surface of solution was exposed to the air. The total atmospheric decomposition being the same in both cases, when distributed over fewer tons of ore would cause a higher consumption of cyanide per ton of ore treated.

In order to ascertain the loss of cyanide to be expected from this cause under the climatic conditions obtaining at this plant, a series of experiments was made in which solutions in glass beakers were left standing exposed to the air of the mill-office. These were titrated at regular intervals by the ordinary Liebig method without an

indicator. In each case distilled water was added to the beakers before making the titration to compensate for any decrease in volume caused by evaporation.

In series No. 1, the solutions were made of as nearly the same strength as possible from chemically pure potassium cyanide, commercial potassium cyanide, chemically pure sodium cyanide, and commercial sodium. These solutions were allowed to remain in open lipless beakers for a total period of 216 hours. Titrations were made at intervals of from one to two days. Table I shows the decrease in the cyanide strength for the various intervals.

TABLE I

Hours	Strength of Solution			
	KCN C.P.	KCN Com.	NaCN C.P.	NaCN Com.
0	0.217	0.223	0.201	0.222
48	0.116	0.159	0.138	0.151
72	0.082	0.126	0.119	0.128
96	0.027	0.085	0.083	0.087
144	0.010	0.015	0.029	0.019
216	trace	trace	trace	trace

After 216 hours the cyanide had entirely disappeared from all the solutions.

A similar series of tests was made with various makes of chemically pure cyanide, commercial cyanide with lead acetate, as well as 'milling' solution and 'barren' solution taken from the storage-tanks. Cyanide was determined by titration as before. The results of this series of tests are shown in Table II.

TABLE II

Hours	Strength of Solution					
	KCN C.P. Merck	NaCN C.P. Kahlbaum	KCN Com.	KCN C.P. E. & A.	NaCN C.P. Pb. Act.	Milling Sol. Barren Sol.
0	0.090	0.095	0.092	0.051	0.091	0.093
24	0.072	0.076	0.072	0.035	0.069	0.069
48	0.037	0.042	0.033	0.016	0.027	0.030
72	0.014	0.017	0.011	0.003	0.005	0.029
96	0.003	0.003	0.002	0.001	0.001	0.014
						0.023

These results confirm those previously obtained, with the exception that the milling and barren solutions from the mill show considerably less decomposition than the solutions made up from fresh cyanide to which no protective alkalinity had been added.

This points strongly to the fact that the double cyanides, particularly in the presence of protective alkalinity, are not as readily decomposed as the simple cyanides under the same conditions. This also helps to explain why it is that actual mill-results frequently show less cyanide consumption than is indicated by small-scale tests made with fresh solution.

In order to determine whether the decomposition was due to the air or to light, another series of tests was made employing a solution made from commercial cyanide. One-third of this was placed in an open beaker, one-third in a stoppered bottle that was protected from the light, and one-third in a stoppered bottle that was

¹The South African investigations had not been made at the time this was written. See M. & S. P., January 8, 1916.

exposed to the light. Titrations were made upon these solutions at the intervals noted. The results of this series are given in Table III:

TABLE III

Hours	Open Beaker KCN, %	Stopped Bottle KCN, %	Stopped Bottle in the Dark KCN, %
0	0.096	0.096	0.096
24	0.064	0.092	0.096
48	0.041	0.095	0.095
72	0.025	0.094	0.094
96	0.024	0.094	0.094
120	0.004	0.097	0.094
168	0.003	0.095	0.096
192	.....	0.096	0.095

In the time generally required for cyanide treatment, light has practically no effect upon the decomposition of solutions of the concentration ordinarily used in mill practice.

At the time that these tests were made it was thought that the rapid decomposition indicated was due to the peculiar climatic conditions obtaining in Central America and that the decomposition would not be nearly so great in a temperate climate.

Some time ago Allan J. Clark² called the attention of one of us (G. H. C.) to a similar test made by him at the Homestake mine that showed substantially the same cyanide decomposition. He exposed 500 cc. of KCN and NaCN solution, to which had been added 0.05 grams of lime, to the air in shallow evaporating dishes. Titrations were made daily:

TABLE IV

Hours	Strength of Solution NaCN (in terms KCN),	KCN, %
0	0.25	0.593
24	0.21	0.169
48	0.133	0.095
72	0.058	0.020

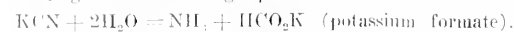
The observations of Clark, together with those previously made by Clevenger, has led us to investigate the subject more fully.

The following statement regarding the decomposition of cyanide by air are to be found in current technology.

Thorp³ states that "dilute solutions of potassium or sodium cyanide decompose very slowly in contact with the atmosphere, the loss being almost wholly due to absorption of carbon-dioxide. Alkali cyanides yield ammonia and a formate when boiled with water."

Watt⁴ states that "aqueous solutions of potassium cyanide decompose in air, slowly at ordinary temperatures, rapidly at 100° C., giving potassium formate and ammonia."

Thorp⁵ states that the aqueous solution of potassium cyanide decomposes on standing or when warmed according to the following equation:



Allen⁶ states that potassium cyanide decomposes slowly in water, forming potassium carbonate, potassium formate, and ammonia.

Julian & Smar⁷ state that "even water decomposes single cyanides by hydrolytic action" * * * but "a

weak acid, such as carbonic acid, has a stronger action by thousands of times" * * * "Carbonic acid is absorbed by cyanide solutions from the atmosphere and, in absence of excess of free alkali, HCN is evolved. In moderately still air a square yard of surface absorbs 1000 cc. of CO₂ per hour and in a strong wind or by constantly stirring it absorbs 1200 to 1300 cc. per hour. The rate of absorption is hardly affected by the amount of alkali present within working limits but the tension of the CO₂ has a marked influence. The figures given refer to cases where the top of the tanks is several feet above ground level. But when the top of the tanks is on the level or below the level of the surrounding ground, the rate of absorption may be three or four times as fast. The presence of soluble and insoluble carbonates facilitates decomposition of cyanides."

In order to study the reactions taking place during the atmospheric decomposition of weak solutions of the alkaline cyanides, it became necessary to determine cyanide, cyanate, hydrate, carbonate, ammonia, and formate. The following methods for these determinations were used.

CYANIDE. (1) Liebig method.⁸ A 25 cc. sample of solution, to which two drops of KI had been added, was titrated with standard AgNO₃ solution to the first faint yellow opalescence. Titration of the solution without the addition of an indicator was used when zinc was present.

(2) Victor method.⁹ An excess of standard AgNO₃ solution (generally 10 cc.), together with 10 cc. of 1:1 HNO₃, was added to a 10 cc. sample of the solution contained in a 100 cc. volumetric flask. After diluting to the 100 cc. mark and filtering, the excess of silver nitrate in 50 cc. of filtrate was determined after the addition of 5 cc. of HNO₃ and 5 cc. ferric alum indicator by titration with standard potassium sulphocyanate solution (Volhard method).

Allen¹⁰ states that, unless the directions for performing this method are closely followed, unsatisfactory results may be obtained on account of the appreciable solubility of AgCN in dilute HNO₃. Our experience with this method is that, even when every precaution is taken, the results are generally slightly lower than those by the Liebig method.

CYANATE. Paterno and Pannin's method¹¹ for cyanate, hydrate, and carbonate is rather uncertain when applied to dilute solutions, on account of the behavior of silver cyanate.

Herting's¹² method for cyanate involves the conversion of the cyanate into an ammonia salt, followed by distillation with caustic soda. The NH₃, in the case of considerable amount of cyanate, may be collected in standard acid and determined by titration, while with small amounts of cyanate the NH₃ is collected in distilled water and determined by Nessler reagent. This

⁷"Cyaniding Gold and Silver Ores." By H. Forbes Julian and Edgar Smart. P. 109.

⁸"Chemistry of Cyanide Solutions." J. E. Glennell. P. 8.

⁹*Zeit. für Anal. Chem.* 10 (3) 462.

¹⁰"Commercial Organic Analysis." Vol. VII, p. 487.

¹¹*Gazzetta Chimica Italiana*, 34 (2) 152.

¹²*Zeit. für Angew. Chem.* 24, 585.

¹Personal communication (1912).

²"Dictionary of Applied Chemistry." Vol. 2, p. 198.

³Watt's "Dictionary of Chemistry." Vol. 2, p. 346.

⁴"Industrial Chemistry." Thorp. P. 296.

⁵"Commercial Organic Analysis." Allen. Vol. 7, p. 473.

method was checked as follows: One tenth gram of Kahlbaum's C.P. potassium cyanate was dissolved in 50 cc. distilled water. 10 cc. of 1:1 HNO_3 was added to 10 cc. of this solution and evaporated to dryness. After taking up with distilled water, an excess of NaOH solution was added and the mixture distilled. The NH_3 was collected in distilled water and determined calorimetrically by Nessler reagent. The potassium cyanate calculated from the NH_3 found corresponded to 96% of the cyanate that had been added by weight. In view of the instability of the cyanates, this result is probably very close to the actual cyanate content. This method is open to the objection that it also indicates any ammonia salts present.

Bettel¹³ gives a method for determining NH_3 , involving the precipitation of cyanogen compounds, by a slight excess of AgNO_3 , precipitation of the excess AgNO_3 by a few drops of HCl and then distillation of the filtered solution with an excess of NaOH. The distillate is collected in distilled water and NH_3 estimated calorimetrically by Nessler reagent.

As there is no satisfactory method for the determination of cyanate in cyanide solutions in the presence of NH_3 , after considerable investigation based upon the work of Herting and Bettel, we developed the following method for the determination of nitrogen in dilute cyanide solutions in other forms than cyanide.

NITROGEN IN OTHER FORMS THAN CYANIDE. 10 cc. of standard AgNO_3 and 10 cc. of 1:1 HNO_3 were placed in a 100 cc. volumetric flask and 10 cc. of the cyanide solution to be analyzed added. The flask was filled with distilled water to the 100 cc. mark and, after shaking, filtered. The excess silver in 50 cc. of the filtrate was precipitated with NaCl and, after dilution to 100 cc., 50 cc. was distilled with an excess of NaOH. The NH_3 in the distillate was determined calorimetrically with Nessler reagent.

Two drops of phenol-phthalein were added to the samples after determining cyanide by the Liebig method and the alkalinity determined by titrating with standard oxalic acid solution. The above method of titration indicates one-half of the mono-carbonates present, as well as the alkaline hydrates. When soluble carbonates were present, they were first precipitated by the addition of $\text{Ba}(\text{NO}_3)_2$, filtration being unnecessary.

CARBONATES. The following method for carbonates is a slight modification of that given by Clennell.¹⁴

Ten cubic centimetres of a saturated solution of $\text{Ba}(\text{NO}_3)_2$ were added to a 25 cc. sample of the solution; after filtering and washing the precipitate, the moist filter-paper was placed in an Erlenmeyer flask, 10 cc. of $n/10$ HNO_3 added, and the filter-paper macerated; then titrated with $n/10$ NaOH, using two drops of methyl orange as an indicator. This method gives the carbonate, together with one-half of the bi-carbonate. It was checked upon a weighed quantity of dried C.P. potas-

sium carbonate and found to give the theoretical percentage of carbonate.

FORMATES AND ACETATES. Considerable difficulty is encountered in determining formates quantitatively in the presence of the other decomposition products of cyanide. However, there are a number of qualitative tests that are satisfactory. With cyanide solutions of the concentration and at the temperatures employed in these tests, it was impossible to detect either formates or acetates.

DECOMPOSITION TESTS IN OPEN BEAKERS. Atmospheric decomposition was investigated by exposing the various solutions to the air. Each solution was placed in an open glass beaker $5\frac{1}{2}$ in. diam. and $8\frac{1}{2}$ in. high; this filled the beaker to a depth of $6\frac{1}{4}$ in., as shown in Fig. 1. The beaker was placed in a room having good

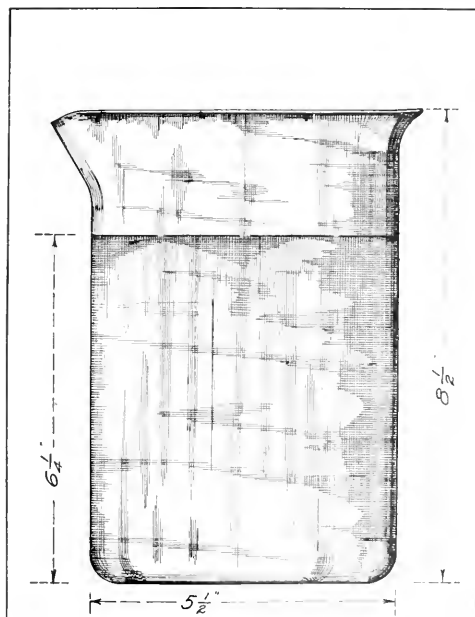


FIG. 1. DETAIL OF BEAKERS USED FOR CONTAINING CYANIDE SOLUTIONS UNDERGOING ATMOSPHERIC DECOMPOSITION.

ventilation and entirely free from laboratory fumes. In each case, before removing the samples for analysis, the solution from the beaker was transferred to a graduated glass cylinder and the exact amount of distilled water added to compensate for evaporation.

Series A. 2000 cc. each of 0.1% and 0.2% solutions were prepared by weight from Merck's C.P. potassium cyanide. No alkali was added.

Temperature Max. F.	Min. °F.	Days	KCN by Liebig Titration	
			0.1% Sol.	0.2% Sol.
75	58	2	0.196	0.008
73	62	7	0.175	0.075
72	61	9	0.125	0.067
72	61	9	0.093	0.047
76	68	11	0.050	0.022
78	58	11	0.033	0.013
78	59	16	0.023	trace
80	54	18	0.010	
..	..	1	Trace	

¹³Technical Analysis of Cyanide Working Solutions.' By W. Bettel. Proceedings of the Chemical and Metallurgical Society of South Africa. Vol. 1, p. 168.

¹⁴Chemistry of Cyanide Solutions.' By J. E. Clennell. P. 67.

It will be noted that a steady loss of cyanide is shown, but at not so rapid a rate as indicated by Tables I, II, and III. This is probably due to the fact that these tests were made in larger beakers and possibly to a less extent to the difference in climatic conditions between Central America and California.

Series B. 2000 cc. each of 0.10% and 0.40% cyanide solution were prepared by weight from Merck's C. P. potassium cyanide and distilled water. No alkali was added. Both cyanide and carbonate were determined at the intervals noted.

Temp.	0.1% Sol.	0.4% Sol.	0.1% Sol.	0.4% Sol.
Max. Min. F.	KCN, %	K ₂ CO ₃ , %	KCN, %	K ₂ CO ₃ , %
Days	0	0.1	0.0	0.2
65	51	0.083	0.023	0.168
64	59	0.062	0.051	0.148
64	58	0.056	0.083	0.125
64	56	0.042	0.096	0.110
66	60	0.030	0.116	0.089
70	62	0.029	0.083	0.073
70	61	0.020	0.057	0.176
70	58	0.015	0.047	0.197
70	65	0.018	0.031	0.210
68	66	0.011	0.021	0.135
			0.021	0.108

Cyanide was determined in this series by the Victor method. The results of Series B are shown graphically in Fig. 2.

Series C. Four portions of 2000 cc. each were prepared of 0.1% solution, employing Merck's C. P. potassium cyanide. The alkalinity was adjusted by varying the proportion of distilled water and lime-water used. One portion contained 80 points¹⁵ of alkalinity, one 40 points, one 20 points, and one 10 points. Cyanide, protective alkalinity, and nitrogen in other forms than cyanide were determined at the intervals noted.

The results of Series C are shown graphically in Fig. 3. This shows the effect of the alkali lime in lowering

¹⁵One hundred points of alkalinity correspond to a saturated solution of lime in water at ordinary temperatures; that is, 0.13%.

the rate of decomposition of the cyanide. It is to be noted that nitrogen in other forms than cyanide remains practically constant.

Series D. This series was the same as Series C, except that the solutions contained 0.20% cyanide:

The results of Series D are shown graphically in Fig. 4. This series confirms the results of Series C upon a solution of double the cyanide strength.

Series E. Two portions of 2000 cc. each of 0.2% solution were prepared, employing Merck's C. P. potassium cyanide. To one portion sufficient KOH was added to give 30 points of protective alkalinity; further additions were made every two days in order to maintain the alkalinity. To the other portion, 4 grams of C. P. K₂CO₃ was added at the beginning, but no later additions of K₂CO₃ were made.

Days	Temperature Max. Min. F.	KCN, %	Pro- tec- tive alkali	Protec- tive alkalin- ity after adding BaNO ₃	KCN, %	Protec- tive alkali
0	66	0.196	30	30	0.196	21
2	66	0.194	22	1	0.170	28
4	68	0.190	48	0	0.154	lost
6	66	0.186	56	2	0.132	34
8	66	0.180	82	2	0.116	42

NOTE. Cyanide was determined by the Liebig method.

The results of Series E, together with the curve for the decomposition of a 0.2% cyanide solution without alkalinity from Series B and the curve for the decomposition of a 0.2% cyanide solution having an initial alkalinity of 20 points of lime from Series D are shown graphically in Fig. 5.

It will be noted that the constant addition of an alkaline hydroxide makes for the lowest decomposition of cyanide.

Series F. In order to study the gaseous products of the atmospheric decomposition of cyanide solutions, the

ALKALINITY OF THE LIME

Days	Temperature Max. Min. F.	50 Points			40 Points			20 Points			10 Points		
		KCN, %	Pro- tec- tive Alkali	Nitrogen in other forms than Cyanide, %	KCN, %	Pro- tec- tive Alkali	Nitrogen in other forms than Cyanide, %	KCN, %	Pro- tec- tive Alkali	Nitrogen in other forms than Cyanide, %	KCN, %	Pro- tec- tive Alkali	Nitrogen in other forms than Cyanide, %
0	70	0.058	80	0.06	0.098	40	0.04	0.008	20	0.04	0.008	10	0.04
2	70	0.056	65	0.06	0.095	26	0.04	0.002	10	0.04	0.002	2*	0.04
4	69	0.055	42	0.08	0.093	11	0.04	0.007	0	0.04	0.078	3*	0.06
6	66	0.051	31	0.10	0.087	4	0.04	0.073	1*	0.04	0.058	4*	0.04
12	68	0.043	25	0.08	0.071	0	0.04	0.052	8*	0.04	0.040	8*	0.04
15	66	0.041	17	0.08	0.055	2*	0.04	0.031	7*	0.04	0.024	11*	0.04
19	66	0.038	6	0.06	0.035	7*	0.04	0.017	9*	0.04	0.013	11*	0.04

*After addition of barium nitrate, no protective alkalinity was shown.

Days	Temperature Max. Min. F.	Alkalinity 80 points (lime)			Alkalinity 40 points (lime)			Alkalinity 20 points (lime)			Alkalinity 10 points (lime)		
		KCN (Liebig), %	KCN (Victor), %	Nitrogen other than cyanide, %	KCN (Liebig), %	KCN (Victor), %	Nitrogen other than cyanide, %	KCN (Liebig), %	KCN (Victor), %	Nitrogen other than cyanide, %	KCN (Liebig), %	KCN (Victor), %	Nitrogen other than cyanide, %
0	70	0.196	0.195	80	0.04	0.196	0.195	40	0.04	0.195	0.195	20	0.04
2	70	0.191	0.187	68	0.06	0.178	0.187	3	0.04	0.178	0.167	3	0.04
6	69	0.187	0.183	41	0.06	0.182	0.182	2	0.04	0.172	0.172	2	0.06
12	68	0.184	0.178	35	0.08	0.176	0.167	4	0.08	0.167	0.167	4	0.06
15	66	0.182	0.167	25	0.08	0.153	0.147	2*	0.08	0.147	0.147	2*	0.06
19	66	0.178	0.161	16	0.08	0.126	0.117	5*	0.08	0.126	0.117	5*	0.08
20	66	0.115	0.120	0	0.08	0.075	0.065	16*	0.08	0.075	0.065	16*	0.08

*After addition of barium nitrate, no protective alkalinity shown.

apparatus shown in Fig. 6 was set up. *A* is an ordinary laboratory filter-pump; *B* a large glass bottle nearly filled with water, which, through the medium of an adjustable glass tube communicating with the outside air, acts as a pressure regulator; *C* is a Junker's gas meter for measuring the volume of air used; *D* and *E* are U-tubes containing 10% KOH solution; *F* is a U-tube containing concentrated H_2SO_4 ; *G* is a glass bottle containing cyanide solution over which the air is passed (detailed drawing of this bottle is shown in Fig. 7); *H* is a U-tube containing 10% KOH or distilled water, depending upon the test; *I* is a U-tube, not shown, containing 10% KOH, only used when the CO_2 was to be removed from the air before passing over the cyanide solution; *J* and *K* are wash-bottles containing concentrated sulphuric acid.

In tests No. 1 and 3 of Series F no alkali was added to the solution, nor no provision made for the removal of CO_2 from the air. It is of interest to note that a large proportion of the cyanide lost from the solution is recovered by absorption in an alkaline hydroxide solution. This indicates that the major portion of the decomposi-

tion involves the formation of HCN. Additional light is thrown upon the reactions taking place through the finding of NH_3 in the gaseous products of decomposition.

In test No. 4, CO_2 was removed from the air by passing it through a solution of KOH, but no alkali was added to the solution. In this test there was some carbon-

ate of ammonia formed, but the decomposition of cyanide was much less than in the absence of alkali when CO_2 was not removed from the air. In test No. 2, in which the CO_2 was removed from the air and alkali added to the solution, the cyanide decomposition is still less than in test No. 4. In test No. 5, the CO_2 was not removed from the air, but the solution contained a comparatively high alkalinity due to lime.

In test No. 6 both lime and zinc were present, so that this solution was similar to a mill solution. These two tests, while not for so long a period as the other tests, indicate the retardation in atmospheric decomposition possible if there be sufficient protective alkalinity present in the solution.

THE CHEMISTRY OF ATMOSPHERIC DECOMPOSITION. The chief products of atmospheric decomposition of weak cyanide solutions are:

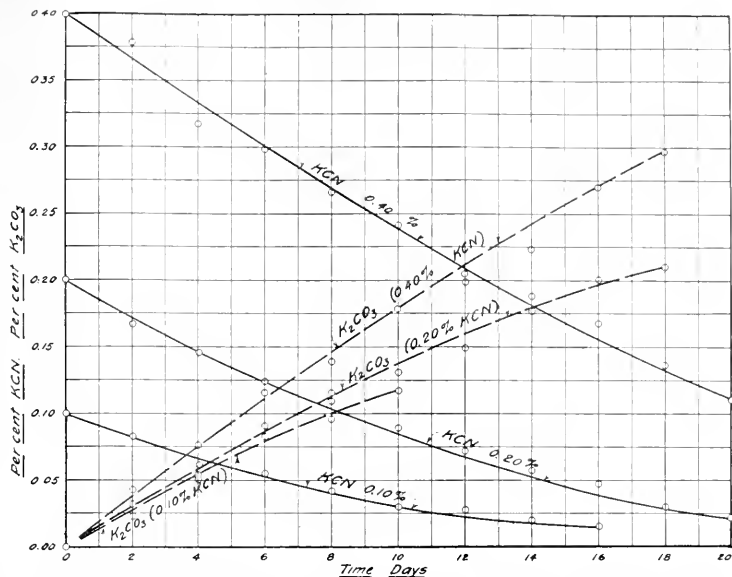


FIG. 2. CURVES SHOWING LOSS OF KCN AND GAIN IN K_2CO_3 THROUGH ATMOSPHERIC DECOMPOSITION OF 0.10%, 0.20%, AND 0.40% KCN SOLUTIONS CONTAINING NO PROTECTIVE ALKALINITY.

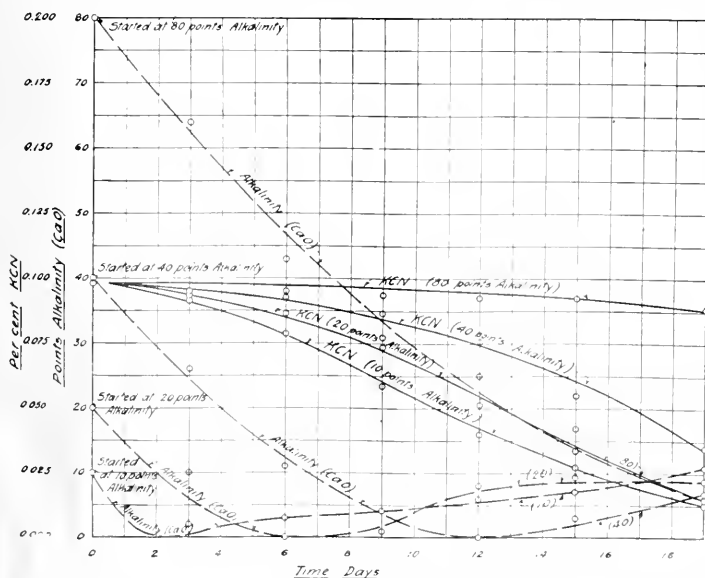


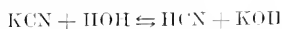
FIG. 3. CURVES SHOWING THE INFLUENCE OF VARIOUS DEGREES OF PROTECTIVE ALKALINITY UPON THE ATMOSPHERIC DECOMPOSITION OF A 0.10% KCN SOLUTION.

(1) Alkaline carbonate, which remains in the solution as soluble sodium or potassium carbonate, depending upon which alkaline cyanide is used, in the absence of calcium hydroxide (lime); in the presence of calcium hydroxide, the carbonate is precipitated from solution as rapidly as formed as insoluble calcium carbonate.

(2) Hydrocyanic acid, which mostly passes off into the air as a gas unless there is an excess of alkaline hydroxide present.

(3) Ammonia, which also mostly passes off into the air as a gas.

Potassium cyanide¹⁶ in aqueous solution hydrolyses¹⁷ as shown by the below equation:



In this reaction, which is a balanced one, H_2O may be considered a weak acid, which, like any other acid, liberates a certain amount of acid (HCN in the form of gas in this case) from the KCN dissolved in it.

Hydrolysis proceeds until equilibrium is established for the particular concentration of cyanide in solution. Moir¹⁸ has published a table showing the hydrolysis of pure NaCN at a summer temperature (in South Africa); results are stated to be 10 to 15% lower in the winter. It will be noted from these figures that the hydrolysis becomes greater as the solution becomes more dilute.

Removal of KOH from the right of the equation causes the reaction to proceed in that direction until equilibrium is established. Consequently the addition of sufficient acid to the solution to combine with the KOH as rapidly as formed causes the hydrolysis to proceed until all the KCN has been converted into HCN.

Y = total cyanide as KCN.

X = portion hydrolyzed to HCN, but calculated as KCN.

Z = portion hydrolyzed to NaOH, calculated as NaOH.

¹⁶Throughout this discussion, for the sake of convenience, potassium cyanide is used as implying either sodium or potassium cyanide.

¹⁷The mechanism of the hydrolysis of KCN according to the ionic theory is as follows: "In aqueous solution potassium cyanide is ionized in the ordinary manner into K^+ and CN^- ions, but water itself is ionized to a certain extent ($\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$) and, as hydrogen cyanide is a very feeble acid and, therefore, ionized to only a very slight extent in aqueous solution, there

is a tendency for the H^+ ions of the water to combine with the CN^- ions from the cyanide, yielding undissociated HCN, the result is that the equilibrium ($\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$) is destroyed and more molecules of water are ionized, but this results in further combination between H^+ and CN^- ions and, by this means, an excess of OH^- over H^+ ions is produced and thus the alkaline reaction. The changes continue until ultimately an equilibrium is established between the KCN, CN, K, H, OH, HCN, and H_2O present."—Dictionary of Applied Chemistry, Thorpe, Vol. III, p. 74.

¹⁸'Loss of Cyanide and Value of Protective Alkali.' By James Moir. Jour. Chem. Met. & Min. Soc. of S. A., Vol. 16, p. 9.

SERIES "F"
Nitrogen in other forms than cyanide was not determined in the solutions of this series.

In each of these tests 250 cc. of cyanide solution was used.														Nitrogen in other forms than cyanide was not determined in the solutions of this series.																																																																																																																																																																																																																																																																																																																																																																						
No. of test	Description	Temperature		At Start				At End				At Start				At End				Total KCN accounted for, Gm.	KCN not accounted for, Gm.																																																																																																																																																																																																																																																																																																																																																															
		Maximum, F.	Minimum, F.	KCN, %	Alkaline hydroxides (KOH), %	K ₂ CO ₃ , %	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.			Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	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K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.	Alkaline hydroxides (KOH), Gm.	K ₂ CO ₃ , Gm.	KCN, Gm.

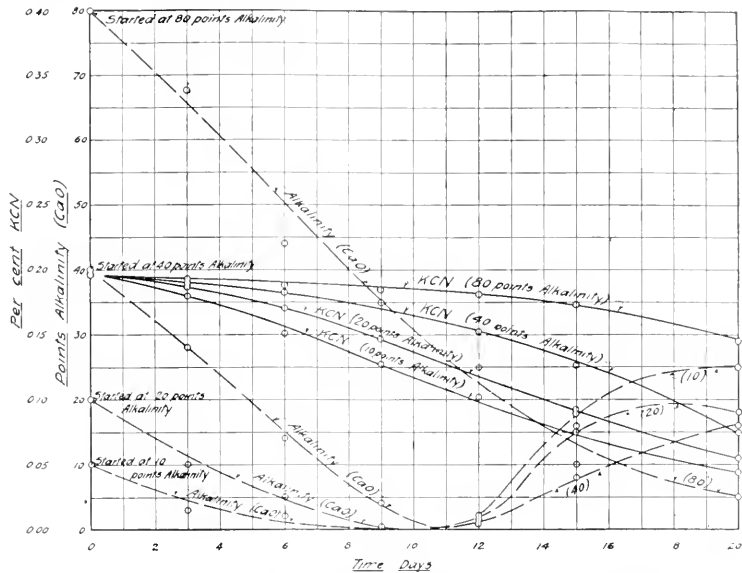


FIG. 4. CURVES SHOWING THE INFLUENCE OF VARIOUS DEGREES OF PROTECTIVE ALKALINITY UPON THE ATMOSPHERIC DECOMPOSITION OF A 0.29% KCN SOLUTION.

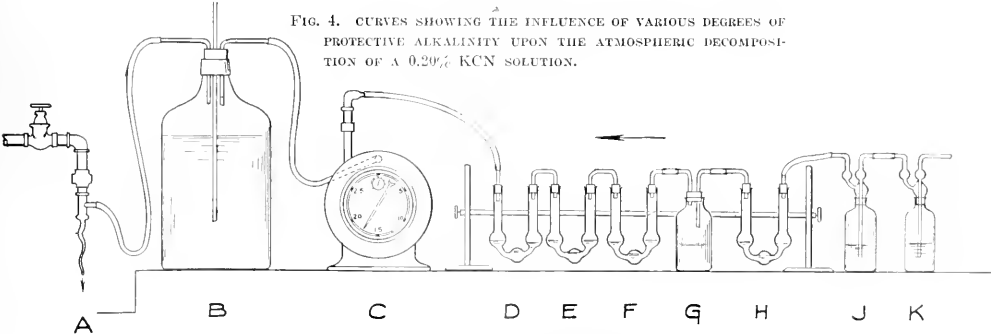


FIG. 6. GENERAL ARRANGEMENT OF APPARATUS FOR SUBJECTING A CYANIDE SOLUTION TO ATMOSPHERIC DECOMPOSITION AND COLLECTING THE GASEOUS PRODUCTS OF DECOMPOSITION.

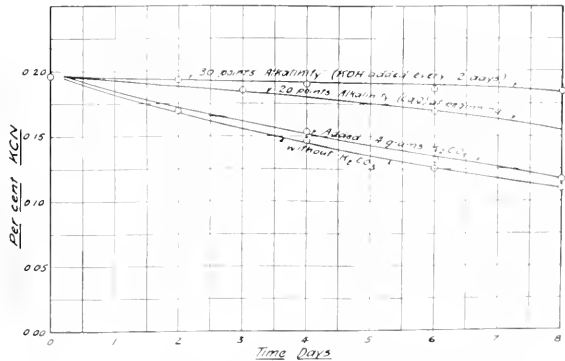


FIG. 5. CURVES SHOWING THE EFFECT UPON ATMOSPHERIC DECOMPOSITION OF THE ADDITION OF VARIOUS ALKALIES TO A 0.29% CYANIDE SOLUTION.

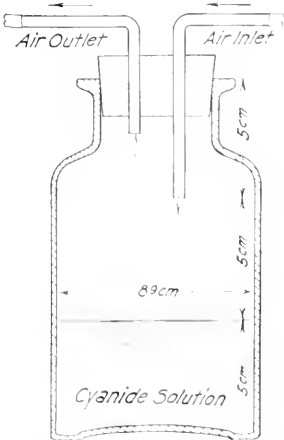


FIG. 7. DETAIL OF BOTTLE USED FOR CONTAINING CYANIDE SOLUTION UNDERGOING ATMOSPHERIC DECOMPOSITION.

100 x =		100 z =	
Y	X	Y	Z
1.90	0.0077	0.8	0.0047
0.50	0.0054	1.1	0.0033
0.30	0.0042	1.4	0.0026
0.20	0.0034	1.7	0.0021
0.10	0.0024	2.4	0.0015
0.05	0.0017	3.4	0.00105
0.02	0.0011	5.4	0.0007
0.01	0.0008	7.7	0.0005
0.005	0.0005	11.0	0.00033
0.001	0.00024	24.0	0.00015

This is well illustrated by the fact that it is impossible to determine the degree of hydrolysis by direct titration of the KOH formed with a standard acid. Cyanide solutions invariably show an alkaline reaction with indicators such as phenol-phthalein, methyl orange, etc., on account of the alkaline hydroxide present by reason of hydrolysis. Upon the addition of standard acid, the alkaline hydroxide is neutralized and the equilibrium which previously existed is destroyed, so that more salt is hydrolyzed to restore the equilibrium. This continues until the point of neutrality is reached, when all the cyanide is decomposed.

Even a comparatively weak acid like H_2CO_3 will react with the caustic alkali added to cyanide solutions or formed through their hydrolysis. This is precisely the effect which the CO_2 in the air¹⁹ has upon a mill solution with which it comes in contact. Therefore, in the case of a mill-solution that contains no protective alkalinity, the HCN that may be lost through normal hydrolysis of the cyanide may be comparatively small but, if sufficient air is brought into contact with such a solution, a large proportion of the cyanide may be lost through progressive hydrolysis. It should be made clear in this connection that, while the ordinary titration as practised for determining the protective alkalinity of mill-solutions indicates one-half of the alkaline carbonates present in the solution, the carbonate thus indicated is not effective as a protection against atmospheric decomposition. Upon exposure to the air of a cyanide solution containing alkaline hydroxide, the protective alkalinity as determined by Clemmell's method decreases until a point is reached where practically no protective alkalinity is indicated. There is then a gradual increase in the protective alkalinity until all the cyanide has disappeared from solution. This is shown in Fig. 3 and 4, where calcium hydroxide (lime) was the protective alkali used. So long as any protective alkalinity remained, CaCO_3 was precipitated, hence carbonate was not indicated by the Clemmell titration, all the solution samples having been filtered before titration. The low point in the curves, therefore, indicates where all the alkaline hydroxide [$\text{Ca}(\text{OH})_2$] has disappeared from solution. The rise in the curves from this point is due to accumulation of soluble K_2CO_3 . Herein lies a danger (at first sight not apparent) in plants operating with a very low alkalinity, since all the lime in solution may have disappeared before the end of treatment and the protective alkalinity indicated may be entirely due to soluble alkaline carbonate, which does not afford protec-

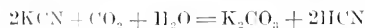
tion against the CO_2 of the air—the most potent agent in atmospheric decomposition. In such cases carbonates should be removed from solution by $\text{Ba}(\text{NO}_3)_2$ before making the titration for protective alkalinity. This is not necessary in solutions containing lime, since CaCO_3 is as insoluble in cyanide mill solutions as BaCO_3 .

Referring again to the equation for the hydrolysis of KCN solution previously given, if KOH be added to the right of the equation the reaction proceeds to the left and hydrolysis is checked. Therefore, the greater the concentration of caustic alkali the less the hydrolysis. This is well shown by results published by Moir.²⁰ While a high protective alkalinity may be desirable from the standpoint of atmospheric decomposition, yet there are other considerations in cyanide practice that cannot be ignored. Lime is the most economical and, commonly, the most satisfactory alkali to use in cyanidation, but, on account of the low solubility of $\text{Ca}(\text{OH})_2$, the amount of lime that can be used effectively is limited. Furthermore, within the limits of the solubility of lime, a high alkalinity may cause an undue consumption of zinc, with its train of attendant evils. A comparatively low alkalinity gives the best extraction with many ores, so that, on the whole, the degree of alkalinity must be a matter of compromise.

Strength of cyanide as KCN, %	Observed alkalinity as NaOH, %	Amount of HCN lost by hydrolysis calculated as KCN, %
0.20	0.02	0.00023
"	0.02	0.00023
"	0.01	0.00060
"	0.005	0.00102
"	0.002	0.00177
0.15	0.03	0.00017
"	0.02	0.00025
"	0.01	0.00046
"	0.005	0.00080
"	0.002	0.00144
0.10	0.03	0.00012
"	0.02	0.00017
"	0.01	0.00022
"	0.005	0.00056
"	0.002	0.00104
0.05	0.03	0.00006
"	0.02	0.00009
"	0.01	0.00016
"	0.005	0.00030
"	0.002	0.00060
0.02	0.03	0.000024
"	0.02	0.000036
"	0.01	0.000072
"	0.005	0.000144
"	0.002	0.000352

Roughly speaking, the addition of alkali equal to $\frac{1}{10}$ of the cyanide causes the recovery of 90% of the lost cyanide.

Carbon dioxide may react directly with KCN according to the equation:



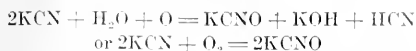
Whether this reaction plays a prominent part during atmospheric decomposition we are unable to say, since the final products of the reaction are the same as those resulting when the intermediate step of hydrolysis takes place. However, it seems probable that this reaction plays a minor part when very small amounts of CO_2 are involved, as in air.

Nitrogen in other forms than cyanide is indicated in all the solutions from series C, D, and E. Ammonia is

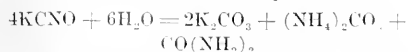
¹⁹Normal air contains 0.02% CO_2 .—"Dictionary of Applied Chemistry," Thorp.

²⁰'Loss of Cyanide and Value of Protective Alkalinity.' By James Moir. Jour. Chem. Met. & Min. Soc. of S. A., Vol. 16, p. 10.

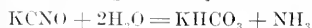
indicated in the gaseous products of decomposition investigated in connection with the tests recorded under series F. It is a well known fact that nascent oxygen forms KCNO when brought in contact with KCN, as, for example, during the electrolysis²¹ of a cyanide solution when the oxygen evolved at the anode combines with the KCN to form KCNO. Our results indicate that the oxygen of the air reacts slowly with KCN, giving first KCNO according to the equation:



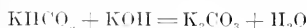
Masson and Masson²² state that KCNO decomposes in aqueous solution according to the equation:



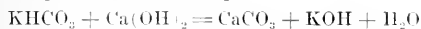
Hamilton²³ states that KCNO decomposes in cyanide mill solutions according to the equations:



In the presence of KOH



In the presence of $\text{Ca}(\text{OH})_2$



The equations advanced by Hamilton harmonize with the finding of NH_3 in the gaseous products of decomposition. The nitrogen in other forms than alkaline cyanide found in the solutions after decompositions is due to undecomposed KCNO, an NH_3 salt in solution or $\text{CO}(\text{NH}_2)_2$ (urea).

SOUTH AFRICAN INVESTIGATION. When the European war threatened to interfere with the furnishing of an adequate supply of chemicals for the Rand, the Chamber of Mines made an appropriation for the study of cyanide losses. Experiments were made by C. A. Meiklejohn under the direction of a committee composed of W. A. Caldecott, K. G. Graham, E. H. Johnson, and H. A. White. An account of this investigation was published by H. A. White²⁴ in September 1915.

In the same journal, H. M. Leslie²⁵ published an account of his experiments. These two investigations cover a portion of the work done by us. Although our experimental work had been completed and this paper written, with the exception of the experiments recorded under series F, before the South African investigations were begun, it is of interest to note that the problem was attacked in the same general way, namely, by exposure of the solution in open containers to the air. The delay in presenting our results was occasioned by the exigencies of other work.

The portion of White's paper dealing with atmospheric decomposition may be summarized as follows: The first experiments were conducted in uniform glass jars holding about 300 cc., placed on a board above the sump. This gave a surface exposure of 84 sq. ft. per ton of solution as compared with 5 sq. ft. in a sump 6 ft. deep. No correction was made for evaporation, which would tend to cause the decomposition to appear less than it really was. The following conclusions are given as a result of these tests:

(1) Loose or incomplete covering is practically useless in preventing loss of alkali or cyanide.

(2) With weak solution no loss of HCN as total cyanide and but little loss as free cyanide occurs while available protective alkali is present.

(3) With strongest solutions the loss of HCN, both as free cyanide and total cyanide, becomes serious when available protective alkali is below 0.01% NaOH.

(4) Comparing results published by Williams (Jour. Met., Chem., & Min. S. of S. A., Vol. 4, p. 501), it is evident that the presence of zinc enormously decreases the loss of HCN by hydrolysis, etc.

(5) The recurrence of alkaline strength observed in experiment XXI was independently checked and can possibly be accounted for by change of KCN to K_2CO_3 .

Further experiments were run under varying conditions in both open and closed vessels. The following conclusions are drawn from these tests:

(1) The loss is incomparably greater in pure synthetic solutions, even with added alkali, than is the case with ordinary working solutions.

(2) Tables E, F, and M illustrate the very heavy loss shown in the presence of little or no protective alkali when determined with the addition of ferrocyanide. (This suggests that it is safer to omit the addition of ferrocyanide in working tests).

(3) In table G, the increased temperature effect is strikingly apparent, but alkali protection is low.

(4) Tables H, I, J, and K show the much improved results obtainable when the alkali strength (without ferrocyanide) is not allowed to get below 0.030% NaOH. The results shown in table C, where working conditions were attempted, more nearly indicate that decomposition is small as long as real protective alkali is present.

(5) In table L, the attempt was made to keep the alkaline strength up by daily additions of lime, but of course the drop during the 24 hours exposure could not be avoided.

If reference be made to Dr. Moir's valuable note (Jour. of Met. Chem., & Min. S. of S. A., Vol. 17, p. 9), it will be clear that the addition of alkali is of considerable benefit in reducing hydrolysis, which, however, is of secondary importance compared with the protection it gives against decomposition by atmospheric carbon dioxide, which is the principal source of the loss of HCN gas.

Leslie carried on exposure tests in both open and closed vessels from which he draws the following conclusions:

²¹The Electrolysis of Aqueous Solutions of the Simple Alkaline Cyanides.' By G. H. Cheever and M. L. Hall. Trans. Amer. Electrochem. Soc., Vol. 24, pp. 271-289.

²²Zeit. für Physik. Chem., Vol. 70, p. 290.

²³Proc. Chem. & Met. Soc. of S. A., Vol. 4, p. 357.

²⁴Cyanide Consumption on the Witwatersrand.' H. A. White. Jour. Met. Chem. & Min. Soc. of S. A., Vol. 16, pp. 24-26.

²⁵The Prevention of Hydrolysis in Cyanide Solutions.' H. M. Leslie. *Ibid.*, pp. 36-47.

(1) That simple cyanide solutions decompose by the hydrolysis of the solution.

(2) That the percentage loss by this reaction is greater in a given time, the weaker the solution.

(3) That increased temperature accelerates this decomposition.

(4) That the alkali formed as a product of the hydrolytic action has little or no protective action on the remaining cyanide, so that hydrolysis goes on until all the cyanide is destroyed.

(5) That the protection afforded by the addition of an excess of caustic alkali is by no means complete, and that the protection is only of a very temporary nature.

A small demonstration plant was used to ascertain this loss. This was capable of treating one ton of sand or 600 lb. slime at a time, and was so arranged that the whole cycle of the cyanide process could be carried out. Tests were made with both the open and closed systems. Cyanide consumption was found to be larger than in large-scale practice on the same ore. This is explained by small scale operation and the lack of protective paint on iron tanks.

The calculated saving at the Village Deep mill, if a closed system were used, is stated to be 50-60% of the cyanide used. Further tests made in small Brown agitators showed that with excessive air agitation, cyanide consumption was increased. Large-scale trials with working scale Brown agitators at the Modder B mine showed only a trace of cyanide saved. This was attributed to the high alkalinity of the cyanide solutions used, due to the use of zinc dust precipitation. The protective alkalinity was 0.0254%.

Taking up first White's paper: The effectiveness of loose or incomplete covering was not investigated by us, but the conclusion that loose or incomplete covering is not effective is what would be expected, since such covering would not prevent the circulation of the air and might in certain cases even promote it.

Our results regarding the effectiveness of protective alkalinity (alkaline hydroxides) and zinc are in a general way in accord with conclusions 2, 3, and 4; namely, that with sufficient protective alkalinity and a reasonable period of treatment the loss from atmospheric decomposition is not serious. The exact behavior of zinc is not clear, but the fact that mill solutions in general give lower cyanide consumption than fresh solutions in a general way confirms the conclusion reached under (4).

The "reemergence"^{22c} of the alkaline strength referred to under (5) and said to be possibly accounted for by the change of KCN to K_2CO_3 , we have definitely proved to be due to the accumulation of K_2CO_3 in the solution. This is well shown by our tests recorded under series C and D.

While doubtless it is true that the atmospheric decomposition of pure synthetic solutions is greater even when alkaline hydroxides are added, than with working

solutions, we cannot agree that it would be so great as the statement under (6) would indicate.

Under (7) it is suggested that it is safer to omit the addition of ferrocyanide previous to the determination of protective alkali. This suggestion is made on account of the fact that the ferrocyanide precipitates zinc with an accompanying increase in the alkalinity of the solution. The alkalinity thus indicated is not available for the protection of the cyanide.

Although the tests referred to under (8) are inconclusive and no special investigation was made of this point by ourselves, we are convinced that higher temperature causes increased decomposition of cyanide.

We are entirely in agreement with the statement under (9) that atmospheric decomposition is small so long as there is real protective alkalinity present.

The statement under (10) that hydrolysis is of secondary importance compared with the direct decomposition of cyanide by atmospheric carbon dioxide is not justified, since it is impossible to distinguish between this reaction and the one involving the intermediate step of hydrolysis, as the final products of the two reactions are the same. The important point to be borne in mind is that the CO_2 of the air removes the alkaline hydroxide as rapidly as formed by hydrolysis. Hydrolysis would stop as soon as equilibrium was established, provided that the alkaline hydroxide were not converted into carbonate. The rate of decomposition is therefore largely governed by the rate at which alkaline hydroxide is converted into carbonate. The other reactions, as our work shows, involving the decomposition of cyanide by the oxygen of the air, are of minor importance.

Taking up Leslie's paper:

Conclusion (1) may be passed as a general statement more or less in accord with our results.

Under (2), we are of the opinion that while it is true that the degree of hydrolysis is greater with a dilute solution, yet in the presence of protective alkalinity it does not work out this way in practice, for the reason, as previously pointed out, that the rate of decomposition is largely dependent upon the removal of protective alkalinity by the CO_2 of the air. It is a well known fact in mill-work that with sufficient protective alkalinity a weak solution shows less decomposition than a stronger solution, and for this reason as weak a solution as compatible with proper extraction should be used.

The conclusion under (3), that increased temperature accelerates decomposition is in accord with the conclusion of White and ourselves.

The statement under (4) that the alkali formed as a product of hydrolytic action has little or no protective action on the remaining cyanide is not true, only to the extent that the alkaline hydroxide is converted into carbonate. There is no distinction whatever between the alkaline hydroxide formed as a result of hydrolysis and that added; both are effective until rendered inert by the conversion into carbonate by CO_2 of the air, or for that matter, through various other reactions taking place during treatment which may convert it into inert salts.

^{22c}The breaking out again after temporary abatement or suppression. Usually said of something regarded as bad. A poor word to use in this connection, as the meaning is rather veiled.

The statement under (5) that the protection afforded by the addition of an excess of caustic alkali is by no means complete, and that the protection is only of a purely temporary nature would only be true when there was a very low alkalinity at the beginning and this is allowed to fall to the vanishing point or to the point where protective alkalinity again becomes apparent through the presence of carbonates. The results of the large-scale trials with working scale Brown agitators at the Modder B, in which only a trace of cyanide was saved, proves the contention of White and ourselves that sufficient alkaline hydroxide is quite effective in preventing undue atmospheric decomposition. The alkalinity of these solutions (0.0254%) would not be considered high in American practice (0.13% is a saturated solution of lime in water at ordinary temperatures).

IN MILL PRACTICE. The operator will naturally raise the following questions: (1) Is atmospheric decomposition of cyanide a serious factor in operating a cyanide plant? (2) What can be done to recover cyanide lost through atmospheric decomposition, and will it pay to recover it? (3) What can be done to prevent atmospheric decomposition?

These three questions which seem to cover the case fully can now be satisfactorily answered in the light of the South African investigations and our own investigation.

(1) Atmospheric decomposition may become a serious factor with cyanide solutions containing very little or no protective alkalinity, but when a reasonable protective alkalinity, due to alkaline hydroxides, is maintained throughout a reasonable period of treatment, the loss is not serious. When a long period is required, higher losses can be expected, therefore the aim should be to keep down the period of treatment to the lowest point compatible with a satisfactory extraction.

(2) The cyanide lost through reactions with oxygen cannot under any circumstance be economically recovered since the nitrogen is in the form of CNO (cyanate), $\text{NH}_2 \searrow \text{CO}$ (urea), and NH_3 (ammonia). Fortunately the decomposition due to oxygen under ordinary conditions of mill operation is small.

The cyanide lost through the reaction with CO_2 is in the form of HCN, which largely passes off with the air at the top of the treatment tank. This can be recovered by using closed tanks and passing all the air through scrubbing-towers containing lime-water or caustic soda solution, preferably the latter. In our opinion this would possibly only be profitable in the case of cyanide solutions containing little or no alkaline hydroxide.

Another alternative would be to pass the air used in agitation, or necessary in treatment, through a scrubbing-tower containing lime water or caustic soda, which would remove the CO_2 before introducing it into the treatment tank. In this case it would be necessary to cover the tanks in order to exclude outside air.

Still another possibility would be to connect the agitation tanks in such a way that the air introduced into the

first tank would pass through the whole series. A higher alkalinity could be maintained in the lowermost tanks of the series or the air could be discharged into a sump-solution having a high alkalinity. A system similar to the above was employed with the monteju used for agitation in some of the earlier filter-press plants operated in Australia, the air passing from one closed monteju to the next. In the one case with which we are familiar, there was a gain in cyanide strength toward the foot of the system. There are certain mechanical difficulties in applying this idea to agitation-tanks, since the pressure at the head would be considerable. One way of overcoming this, would be to draw air from tank to tank by special compressors. Increased pressures in the treatment-tanks would perhaps not be without its advantage, since there is evidence leading to the belief that with certain ores, at least, there would result a considerable acceleration in extraction.

(3) It will be obvious that the most effective method of preventing atmospheric decomposition is to maintain a sufficiently high concentration of alkaline hydroxides in the solution. In this connection we wish again to call attention to the fact that the method for the determination of protective alkali, as ordinarily practised, records one-half of the alkaline carbonate present and this is not effective for the protection of cyanide against atmospheric decomposition. When lime is not present in solution, carbonates should be removed before testing for protective alkalinity. Since the recovery of the cyanide requires the use of alkaline hydroxides, the most simple procedure is to add these directly to the solution, except possibly in those cases where a very low protective alkalinity is essential to the best extraction. In any event, the matter of alkalinity should not be over-done, since an excessively high alkalinity, while favorable to atmospheric decomposition, causes an undue consumption of zinc with its train of attendant evils. Like many other factors in cyanidation, the alkalinity should be a compromise to give the best all around results.

In conclusion we hope that some operator where the conditions seem to be favorable will make mill-tests upon the recovery of cyanide lost through atmospheric decomposition, and will publish his results for the benefit of others.

THE LEADING PORTS of the world are given by the *American Exporter* in the following order: New York, London, Hamburg, Antwerp, Liverpool, Marseilles, Havre, Bremen, Calcutta, Bombay, Buenos Aires. The foreign trade of New York during 1915 was \$2,125,000,000; that of London \$1,928,000,000. Hamburg's foreign trade in normal times is about that given above for London.

RAMM production in Bohemia, Austria, was 27.07 grains in 1915, valued at \$209,365. Compared with the 1914 yield there was a gain of 13.57 grains. Uraninite prepared for smelting amounted to 25,720 lb., worth \$471.50 per pound.

Agreement Between Minerals Separation and the Inspiration-Anaconda Companies

AGREEMENT made and entered into this — day of February one thousand nine hundred and fifteen by and between MINERALS SEPARATION, LIMITED, whose registered office is situated at 62 London Wall, London, England (hereinafter called the Licensors, which designation shall include its successors and assigns where the context so requires and admits) of the one part and INSPIRATION CONSOLIDATED COPPER COMPANY, a corporation organized and existing under the laws of the State of Maine and having an office at 42 Broadway, New York, N. Y. (hereinafter separately called Inspiration) and ANACONDA COPPER MINING COMPANY, a corporation organized and existing under the laws of the State of Montana and having an office at 42 Broadway, New York, N. Y. (hereinafter separately called Anaconda) of the other part.

WHEREAS a license agreement bearing date April 10, 1913, has been entered into by and between the Licensors and Inspiration and a license agreement bearing even date herewith has been entered into by Anaconda,

AND WHEREAS Inspiration and Anaconda are desirous of entering into a special agreement for a rate of royalty based upon total daily tonnages and are desirous of including certain additional companies hereinafter named for the purpose of increasing the total daily tonnage of material treated,

AND WHEREAS it has been agreed that Inspiration and Anaconda shall pay to the Licensors as a consideration for this agreement a guaranteed minimum royalty of three hundred thousand dollars (\$300,000) in the manner hereinafter set forth,

NOW THIS INDENTURE WITNESSETH that in consideration of the premises and the sum of one dollar by each of the parties hereto to the other in hand paid (the receipt whereof is hereby acknowledged) and of the royalties hereby reserved and of the covenants herein-after contained, it is hereby agreed as follows:

1. Inspiration and Anaconda in place of the royalties provided in clause "I" of each of the said license agreements, shall during the continuance of this agreement, for the purpose of ascertaining and determining the royalty to be paid, have and are hereby given the right of aggregating the total tonnage of copper ores treated by all flotation processes by all of the companies herein designated who shall have taken out Licenses pursuant to clause II thereof. Upon the basis of the aggregate tonnage so produced, it is agreed that the royalties to be paid shall be as follows:

At the rate of 12 cents for each short ton (2000 pounds dry weight) of ore treated when such tonnage does not exceed 4000 tons per day.

At the rate of 10 cents for each such ton of ore treated when such tonnage is more than 4000 tons and does not

exceed 6000 tons per day.

At the rate of 9 cents for each such ton of ore treated when such tonnage is more than 6000 tons but does not exceed 10,000 tons per day.

No charge shall be made nor any royalty paid for each such ton of ore treated over and above 10,000 tons and up to and including 15,000 of such tons per day.

At the rate of 8 cents per ton for each such ton of ore treated over and above 15,000 tons and up to and including 30,000 of such tons per day.

At the rate of 4 cents for each such ton of ore treated over and above 30,000 of such tons per day.

Such rate to be computed upon the total tonnage of material treated each day by Inspiration, Anaconda, and such others of the Companies hereinafter named as shall have had their daily tonnage brought within this agreement, by notification from Inspiration and Anaconda to the Licensors and shall have entered into license agreements with the Licensors as hereinafter provided.

For the purpose of arriving at the daily tonnage treated the total tons of material treated during each quarter shall be computed and divided by the number of days in each quarter except Sundays, and the result of such division shall be deemed to be the daily tonnage treated, the material treated by Inspiration and Anaconda and the other Companies named by all flotation processes to be included in such computation. Provided that such royalties shall be payable quarterly commencing on the first quarter day following the day and year first above written until the sum of \$300,000 shall have been paid, the payment of such sum being guaranteed by Inspiration and Anaconda jointly and severally, and such sum to be paid in any event regardless of the determination of the suit of the licensors and another against James M. Hyde which has been brought on a writ of certiorari to the Supreme Court of the United States, and regardless of the quantity of material treated; and further provided that if the total amount paid as royalties hereunder shall not have aggregated the sum of \$300,000 when the Supreme Court of the United States shall have passed finally upon the said case against said Hyde, Inspiration and Anaconda guarantee that they will within five days after having been notified of such decision by the Licensors pay the deficit, if any, between the total amount of royalties which shall have been paid to it and the sum of \$300,000; it being understood, however, that in the event of a deficit so occurring and Inspiration and Anaconda making the foregoing payment, that such payment shall be credited back as royalties upon the material if any, thereafter treated under this Agreement. If, prior to the decision of the Supreme Court of the United States in said case the total amount of royalties which shall have been paid under this agreement

shall have aggregated the sum of \$300,000, it is understood and agreed that if the Licensees continue to treat material under this Agreement royalties shall be paid as provided in the present clause of this Agreement.

The Licensors hereby consent that for the purpose of treating material by flotation processes, for which royalty has been agreed to be paid hereunder, the Inspiration and Anaconda may install at their own expense and use any apparatus they may choose.

II. Upon notification to the Licensors from Inspiration and Anaconda, the Licensors will enter into separate license agreements with any or all of the following named additional companies, such license agreements to be in the same form as the license agreement above referred to between the Licensors and Anaconda and at the same rate of royalty as is specified therein, said additional companies being as follows:

Greene Cananea Copper Company of Minnesota,
Cibola and Arizona Mining Co. of Arizona,
Arizona Copper Company Limited of Great Britain,
Consolidated Copper Mines Company.

Each of such additional companies and Inspiration shall within fifteen (15) days after each quarter day deliver its quarterly report of tonnages treated in duplicate to Anaconda and the Licensors, and thereupon the royalties on total tonnages shall be paid to the Licensors by Anaconda as above provided with a statement of the total tonnages treated.

III. On or before February 1, 1915, Inspiration shall pay to the Licensors all royalties due or which may be due up to and including December 31, 1914, under its existing license agreement above referred to at the rate of royalty specified therein, such royalty to be computed upon all material theretofore treated by flotation processes, and thereafter during the continuance of this agreement the payment of royalty by Inspiration and during the continuance of this agreement the payment of royalty by Anaconda shall be at the rate based upon daily tonnages and in the manner above particularly stated in Clause I of this agreement, except in so far as it is modified by Clause V of this agreement.

IV. This agreement shall continue until the determination in or dismissal from the Supreme Court of the United States of the aforesaid suit of the Licensors and another against James M. Hyde and until such time thereafter as may be taken by Inspiration and Anaconda for the exercise of the option hereinafter granted, and should such option be exercised favorably to the continuation of the Licenses above referred to, shall be further continued as hereinafter set forth.

V. Inspiration and Anaconda shall each have the option for the period of sixty (60) days after the determination or dismissal from the Supreme Court of the aforesaid suit to elect by notice in writing to the Licensors whether to continue the said license agreements or to terminate the same. Should they elect to continue the same Inspiration and Anaconda jointly and severally undertake and guarantee that royalties at the rates specified in Clause I of this agreement shall be paid upon at

least twenty-five million (25,000,000) tons of material treated from and after the day and year first above written and on or before November 6, 1923, and all of the license agreements above referred to shall be continued in accordance with the provisions thereof, royalties to be paid after payment of royalties under said guarantee for a minimum of 25,000,000 tons of material treated either at the special rate specified in Clause I of this agreement, or at the rates of royalty specified in said separate license agreements at the option of Inspiration and Anaconda, with the privilege to Inspiration and Anaconda to aggregate the total tonnages under all or so many as they may desire of said license agreements in the computation and payment of such royalties. Should Inspiration and Anaconda elect as above provided to terminate the said license agreements, this agreement and each and every of the said license agreements shall be thereby terminated, without prejudice, however, to the recovery by the Licensors of any money then already due or any right of action by reason thereof, and with full freedom to Inspiration and Anaconda and the additional licensees above named to contest the validity of the letters patent of the Licensors or the extent of the monopoly thereby granted and full freedom to the Licensors to enforce their letters patent against Inspiration, Anaconda and the above named additional companies, provided, however, that under such circumstances no patent claims for apparatus will be sued upon by the Licensors in so far as applicable to any apparatus installed while operating under said licenses.

VI. If at any time during the continuance of this agreement after the exercise of the option stated in Clause V of this agreement, by *force majeure*; strikes, general financial disturbances or unavoidable causes, Inspiration or Anaconda, shall find it necessary to temporarily stop or reduce its mining output so that a total average daily tonnage of 15,000 tons or more under this agreement is temporarily reduced below a daily average of 15,000 tons throughout a quarter, then for such period of forced reduced tonnage of material treated, royalty shall be paid at the rate of six cents (6c.) per ton in place of the higher rate provided for such lower tonnage in Clause I of this agreement, provided, however, that all tonnages treated and paid for under such special circumstances shall be excluded from and shall be additional to the guaranteed tonnage of 25,000,000 tons set forth in Clause V of this agreement.

VII. This agreement shall be construed in all respects and take effect as an agreement made in the State of New York and in accordance with the laws of the State of New York.

VIII. This agreement shall be assignable by Inspiration or Anaconda only as an entirety and only to its successor in its present business, and shall inure to and bind such successor or successors.

SIGNED SEALED AND DELIVERED by the parties hereto the day and year first above written.

MINERALS SEPARATION LIMITED,
By S. Gregory, Attorney.

Basic-Lined Copper Converters

*Probably the first attempt to use a converter lined with basic material was that by the late Charles F. Shelby at Cananea in 1907. He gave up the trial as impracticable. Some months later, Messrs. Pierce and Smith proved the basic lining a success at Baltimore and Garfield. From this time onward its use spread considerably, especially in the South-west. Magnesite brick is used in the basic-lined converter.

Operating data of basic-lined converters in the South-west are shown in the following table:

OPERATING DATA OF BASIC-LINED CONVERTERS IN THE SOUTH-WEST.

	1	2	3	4	5	6	7	8	9	10
Blast pressure in pounds	13	13.2	14	12	12.4	12.15	10-14	14	11.3	13
Cu lb air per minute per converter	5,415	7,691	10,600	4,283	6,054	7,330		8,181	4,933	4,117
Cu lb air per ton bullion produced	152,119	178,411	111,000	228,116	271,577	137,582	118,328	225,674	245,975	370,596
Cu lb air per ton iron and sulphur oxidized	96,115	142,221	156,000	98,847	139,361	112,950		119,475	240,937	124,583
Oxygen efficiency, taking into account total iron and sulphur oxidized	84.0	54.1	57.2	76.8	56.3	74.0	81.0	50.6	69.8	59.6
Total tons iron and sulphur oxidized per stand per month	2,075	1,600		1,647	1,903	2,868	1,991	2,576	768	1,440
Punchers used per shift per month	2	2	2	2	2	2	2	2	1.5	2
Tons bullion per puncher per month	231	204	522	115	478	392	255	137	129	240
Tons iron slagged per puncher per month	192	153		169	533	251	171	156	117	
Average time to blow one ton bullion, minutes	4-00	4-11	3-00	6-44	9-20	8-00	8-30	7-12	4-51	10-00
Average time to blow one ton iron and matte, minutes	28	23	14	54	45	19	28	28	51	90
Average weight of matte per charge, tons	8.5	10.8	13.3	8.22	12.7	25.3	18.0	15.6	5.8	6.7
Tons iron charged per ton of matte	21.9	26.0	25.9	33.9	40.5	60.0	30.0	51.2	19.7	26.6
Tons iron slagged per ton of available silica	0.23	0.20	0.155	0.201	0.17	0.25	0.30	0.21	0.286	0.283
Size of converters	12 ft	12 ft	12 ft	12 ft	12 ft	10 by 26 ft	12 ft 6 in by 26 ft 6 in	12 ft	7 ft by 10 ft 6 in	9 ft by 7 ft 6 in
Number of tuyères	28	24	24	24	24	35	21 6 in Falls	22	12	
Size of tuyères, inches	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2 6 in Falls	1 1/2	1 1/2	1 1/2
Thickness of brick used on tuyère line, inches	24	30	30	11	30	18	18	21	18	15
Average slag analysis:										
SiO ₂	19.6	21.7	17.2	17.4	15.6	23.6	25.7	29.2	22.2	23.8
FeO	68.2	67.9	69.1	70.7	67.3	66.2	60.0	62.1	63.4	61.5
CaO	0.8	1.1	0.6	0.8	0.4			1.6	0.9	
MgO	3.3	3.0	3.7	3.0	2.9				2.8	
Average matte analysis:										
Cu	37.7	41.37	54.2	28.22	34.7	43.7	42.8	31.9	35.21	25.0
Fe	32.5	29.2	21.6	30.9	34.9	28.0	27.4	28.8	36.1	16.0
S	27.1	23.5	24.5	25.3	24.9	25.1	25.6	18.7?	25.0	25.0

1. Arizona Copper Co., Clifton, Ariz.

2. Old Dominion Copper Mining & Smelting Co., Globe, Ariz.

3. International Smelting Co., Inspiration, Ariz.

4. Calumet & Arizona Mining Co., Douglas, Ariz.

5. Copper Queen Mining Co., Douglas, Ariz.

* Insoluble

6. Consolidated Kansas City Smelting & Refining Co., Hayden Plant, Ariz.

7. Consolidated Kansas City Smelting & Refining Co., El Paso Plant, Texas

8. Cananea Consolidated Copper Co., Cananea, Sonora, Mex.

9. Detroit Copper Mining Co., Morenci, Ariz.

10. Consolidated Arizona Smelting Co., Humboldt, Ariz.

The most successful run in any converter is that at the Old Dominion smelter at Globe, particulars of which are as under, according to L. O. Howard:

Began operation	June 27, 1913
Removed for initial patching	December 7, 1915
Blowing, hours	13,734
Number of blows made	3,258
Time of blow, hours	4.18
Number of taps of matte	9,316
Matte charged, tons	85,578
Weight of matte per charge, tons	26
Copper content of matte, per cent	43.37
Bullion produced, tons	35,431
Time to blow one ton copper, minutes	23.2
Copper per blow, tons	10.80
Blast pressure, pounds	13.2
Air used to blow one ton copper, cubic feet	178,411
Air used per minute, cubic feet	7,691
Air used per ton of iron slagged, cubic feet	212,502
Ore fed, tons	17,097
Ore fed per ton of matte blown, tons	0.200
Magnesite used for repairs	None

*Abstract from paper prepared for Arizona meeting of American Institute of Mining Engineers.

Manufacture of Electro-Chemical Products

The chief products made by the aid of the electric current are aluminum, phosphorus, silicon, sodium, graphite, chlorine, oxygen, hydrogen; ferro-alloys, copper, titanium, vanadium, and other alloys; calcium carbide, carborundum, and other abrasives; caustic soda, caustic potash, sodium, peroxide, chloride of lime or bleaching powder, carbon bisulphide and muriatic acid. According to a report issued by the U. S. Bureau of Census, the value of electro-chemical products has increased from \$18,450,000 in 1909 to \$29,600,000 in 1914.

This does not include iron and steel made in the electric furnace, which also falls under this class. The extent to which we are dependent on electro-chemical products is little realized. The manufacture of these products has been steadily increasing, but today the supply is far short of the demand, due, in many instances, to the inability to obtain permission from the Government to use more power at Niagara Falls, the great electro-chemical centre. Of 36 establishments reporting in 1914 manufacturing these products, 18 were in New York, 4 in Michigan, 3 in California, 2 each in Pennsylvania and West Virginia, and one each in several other States. Most of the plants in the State of New York are at or near Niagara. The 30th semi-annual convention of the American Electrochemical Society, whose membership includes the foremost electro-chemists of the World, will be held at New York, September 27 to 30, at the time of the Exposition of Chemical Industries.

In 1885 the United States produced 283 lb. of aluminum; in 1915 a total of 99,806,000 pounds.

Flotation Tribulations

By Jackson A. Pearce

Idaho Springs lies within a heavily mineralized district covering the better part of two counties, Clear Creek and Gilpin, in Colorado. Gold, silver, lead, copper, zinc, molybdenum, tungsten, and uranium in most of their manifold mineralogical forms, occur in commercial quantities. In the ores they occur individually and collectively, offering an excellent field for metallurgical research. Within easy reach of Denver with its milling machinery and of Golden, the seat of the Colorado School of Mines, this district is utilized as a testing yard for processes and machinery, falling intermediate between the laboratory and the modern plant. Thus it has become a museum of the world's metallurgical processes. One can find here almost anything from a long-tom to an electrolytic refinery.

Flotation, the most recent process to be placed on exhibition, had been in operation in a couple of local plants a few months before any decision had been made to install a machine at the Argo mill. Much laboratory work had been done on flotation, but as concentration and cyanidation had been running smoothly the desire to change was not burning. However, tests showed that it might be useful on certain low-grade silver ores not particularly well adapted to cyanidation. With this end in view a machine was installed.

Having dedicated the better part of my life to cyanidation, and having contributed largely to the adaptation of cyanidation to these ores, I entered upon flotation with many misgivings, and these few notes may be taken as a confession of a cyanider—not that of a flotation expert.

The preliminary tests were made in a home-made single-cell machine. Especial attention was given to an ore assaying 0.12 to 0.40 oz. gold, 8 to 20 oz. silver, and a strong trace each of copper, lead, and zinc. On account of its relatively high silver-value this ore is not particularly amenable to cyanidation. Although the gold in these ores yields readily to cyanidation the silver is backward, 60% being the average extraction. These tests were carried out with a view to establishing the best conditions as to speed of impellers, consistence of pulp, combination of oils, temperature, and fineness of ore. No critical condition was established in any of these lines, a satisfactory extraction, 85 to 90%, resulting from within wide limits of each. Other gold ores yielded a good extraction by flotation, but not sufficiently to enthrone one as to its preference to cyanidation.

A flotation machine of 100 tons capacity was installed to handle silver ores only, giving us two distinct flowsheets within the mill. The flotation system comprised stamping to 16-mesh, classifying in Dorr machines, concentrating on Card tables, re-grinding in a tube-mill, re-

concentrating on slime-tables, and thickening the combined slime and re-ground sand for flotation. With this arrangement we expected to get 55 to 65% extraction on the tables, and 50 to 60% on the flotation machine, or a mill extraction of 75 to 85%, which, considering the laboratory extraction of 85 to 90%, was a conservative estimate.

In the first three weeks of operation the extraction on the primary tables was 50%, but, contrary to expectation, the extraction in the flotation machine was nothing. Before table concentration this ore carried a trace each of galena, chalcopyrite, and blende, with sufficient pyrite to give a concentration ratio of 4:1. The exceedingly small amount of flotation-concentrate was composed of galena, chalcopyrite, and blende, with an abundance of silica but very little pyrite. The amount of this product was not sufficient to make an appreciable difference in the assays of feed and discharge. I may add that the assays covering this test averaged a shade higher for the discharge than for the feed. This was disconcerting, to put it mildly. Three weeks is not a long time in which to perfect a process, but it's a mighty long time to watch half the value of the ore going into the creek.

During this time we gave particular attention to oils. According to information gathered from reports, and from personal conversation with flotation metallurgists and salesmen, it seemed that the oil was the most important consideration in flotation. It is generally believed that different ores require different oils. Adjoining properties on the same ore deposit seem unable to use the same combination of oils. In this respect the outlook for flotation here was painful to consider, since this is a custom-mill fed by a multitude of mines in a district producing a great variety of ores. During the three weeks we made exhaustive tests, covering a wide range of oils, trying one after another, individually and in combinations. Operators seem to have favorite places in the system for feeding oils, some favoring the batteries, others the tube-mill, and so on, down to the last cell in the machine. We covered everything from the coarse crusher to the tail-race. Special mixers or emulsifiers are in common use, and we installed one. It seemed to make little difference what oil, how much, or where fed; the froth was always the same—abundant and barren. At times it was excellent to the view, according to one metallurgist, "a most beautiful froth," three to six inches deep, bluish black, and covering the entire froth-cell. At other times it was over-abundant, rolling over both ends, back and front of the machine, developing so rapidly that it required the best efforts of two men to sluice it to the creek. We ran it in this manner for 24

hours—not that we wanted the froth, but to ascertain the ratio of extraction to quantity of froth. Although the total amount of material floated was appreciable, there was no difference in assays of heading and tailing, clearly indicating non-selective action.

We used oils furnished by several companies, including crude wood-oils, pine-tar oils, tar, wood-cresote, crude and refined turpentine, asphalt, coal-tar, gasoline, coal-oil, gas-oil, crude oil, and coal-tar cresote.

Regular examination of the tailing showed pyrite in great plenty, every particle of which was thoroughly oiled, and easily floated from the gangue by simple panning. Was there some condition in the machine to disengage these oiled particles from the froth? Or, were they ever attached to the froth? Or to the bubbles preceding the froth? The machine was built with an intricate set of baffles following the agitation, through the tortuous course of which the bubbles might have dropped their burden. We simplified the baffles, trying a dozen different kinds, one after another, terminating a heart-breaking task with no baffles at all. The machine worked as well without as with baffles; so why baffles?

The mineral particles were well oiled, but lacked the balloon arrangement necessary to conduct them to the surface. Perhaps the agitators were not fast enough to churn the air into the oil. Most people emphasize the importance of peripheral speed, some giving 1500 ft. per minute as the best, extraction and power considered. We were operating at this speed, but increased it by stages to 2100 ft. The motor would not carry this load for more than a few hours at a time; besides, the results were no better than at 1500. We decreased the speed to 1200, and, finding it more economical in power and just as efficient in extraction, left it at that. Later on it was reduced to 1100. Turning our attention to ore-fineness we found a wide range of recommendations, some operators recommending—40, some—60, others—100, and yet others close to—200, nearly all contending that the finer the ore the better was the flotation. My own laboratory experiments on this particular ore gave good extractions on a 12-mesh product. We tried everything from a 16-mesh product direct from the stamps to a product 95% of which would pass a 200-mesh screen. While there were no encouraging signs within this range; the advantage, though small, lay with the coarser product.

During these tests (from January to March this year) the temperature hovered around zero, at times reaching 12 to 15° below. Mill-water was close to the freezing-point, and great care had to be exercised to prevent pipes and launders freezing. Although many consider higher temperatures, say 70° F., essential to good work, we were unable to attain this economically, for lack of facilities for returning the mill-water. Nevertheless, to satisfy ourselves on this point, we turned the full capacity of a boiler into the feed, thereby raising the temperature to 60° F. After six hours at this temperature the difference in effect was in no way sufficiently marked to justify heating.

Next we turned our attention to consistence, the general report favoring 6:1 for very fine pulp down to 3:1 for sand. We covered a range from 20:1 to 2½:1, coming to the conclusion we were nosing the wrong scent.

It might be assumed that inexperience in, or prejudice against, the process, to the one or the other of which most failures are due, was at the bottom of our troubles. While I have spent most of my life at cyanidation, and greatly value the process, and perhaps have a soft spot in my heart for it, the fear of failure in any undertaking greatly exceeds any prejudices I may have against it. Also, it may be said, we had the personal services of several distinguished flotation metallurgists, no one of whom was able to suggest any change leading to decided improvement.

It was the firm conviction of one engineer that the machine was over-loaded. Although it was carrying ¾ its rated load, I reduced the feed to 1/40 its rated capacity, not that we could expect to operate on that basis, but to get a clue if possible to the trouble. There was no improvement.

At last we did what at first we would have done with any other process: we investigated the theories. But with flotation, where everybody has gratifying success and nobody has a gratifying theory, it seemed unreasonable that we alone should need a theory. Theories of flotation are now running the gauntlet of thoughtful criticism so essential to the survival of the fittest. "Fittest" in this instance is not amiss, for almost all theories are limited to certain facts, and that theory survives or is accepted which is fittest, that is, which fits the greatest number or widest range of facts. The ionic theory of chemical reactions superseded the affinity theory by virtue of its being more inclusive. No sooner is a flotation theory advanced than there arises a brilliant array of facts tending to disprove it, or, in other words, to limiting its fitness, so that in the present state of the subject it ill becomes us dogmatically to assert that any one is the correct theory, exclusive of all others.

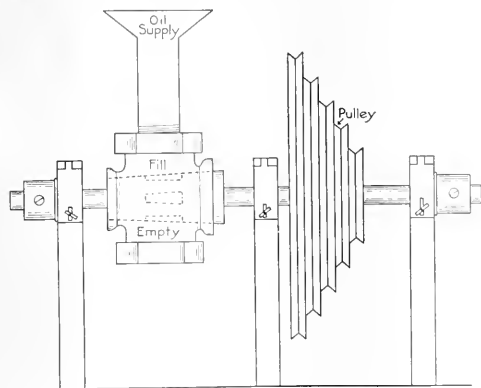
The early efforts to establish a theory involving adhesion, which is only a begging of the question, and one involving the angle of contact or angular hysteresis, have given way to those of more apparent merit involving occluded gases, electro-statics, and interfacial tension. Whether any one of these, or any combination of them, survives is problematical.

Regarding the application of the theory of angular hysteresis, we assumed that the pyrite was not making the desired angle of contact, and, knowing of no way to cause it to do so, we dismissed the subject.

THEORY OF OCCLUDED GAS. The theory of occluded gas so ably advanced by Durell appealed to me in its tangibility. All substances occlude gases, the tenacity of retention being more pronounced in some than in others, but in all cases capable of expulsion by osmotic pressure, increased temperature, or vacuum. Only by virtue of this occluded gas can a bubble of gas be attached to the substance. The sulphides of metals, iron, lead, zinc, etc., constituting the economic portion of the

ore are more tenacious in the retention of the occluded gas than silica, lime, feldspar, etc., constituting the waste portion of the ore. Therefore by regulating the osmotic pressure, temperature, or vacuum the occluded gases of the gangue-material can be expelled entirely, at the same time leaving sufficient gas in the sulphide to act as a nucleus in the formation of adhesive gas-bubbles, thereby giving us 'selective' flotation. Silica was coming over with the froth in preference to sulphides. The evident procedure was to expel the gas from the silica, taking care not to expel it from the sulphides.

We had already tried heat with no success; we were not prepared for trying vacuum; so we tried osmotic pressure. To increase the osmotic pressure, we increased



OIL-FEEDER AT ARGO MILL; ONE-THIRD ACTUAL SIZE. SPEED OF LARGE PULLEY 35 R.P.M.

the number of ions by the addition of some easily dissociated solute, say, sulphuric acid. Acid has the advantage over salts in its power to reduce the surface tension, or the 'surten,'* permitting the formation of bubbles. Starting with a very small amount of acid we increased it gradually to 20 lb. per ton. The more we added the more disheartened we became.

INTERFACIAL TENSION. Roughly stated, water and oil (if insoluble) in contact maintain their individual faces, the oil facing the water, the water facing the oil. This is the interface of the two. Now, introducing a solid, say, a small particle of ore, it is found to have three tendencies; it tends to enter the water only; it tends to enter the oil only; it tends to enter both oil and water. If the tendency to enter both water and oil is sufficiently marked for each liquid, it remains between the two, or on the interface, a phenomenon on which is based the theory of interfacial tension. This was wonderfully exemplified in our machine, the only drawback being that it was the silica that displayed a preference for the interface.

ELECTRO-STATIC THEORY. Gas and oil films are negatively charged irrespective of the electrolyte in which they are formed. Silica, and perhaps silicious gangue,

is negatively charged in the presence of the hydrogen ion, reversing its polarity in the presence of the hydroxyl ion. Sulphides are perhaps positively charged. The mutual attraction of oppositely-charged bodies together with the mutual repulsion of similarly-charged bodies operate to produce selective flotation.

On this assumption we examined the electrolyte: mill-water plus the soluble constituents of the ore. It carried copper and some iron and, among other things, a weak trace of acid. It would seem logical to acidify it more strongly to ensure a negatively-charged silica. But in acidifying to increase the osmotic pressure we observed that it improved neither the osmotic nor electro-static effect. Evidently the pyrite particles were not electrified, or else were unsuitably charged. We induced electrification, or tried to. By the hit or miss method we attempted to get an electrolyte that would make a more desirable distribution of the electric charges. We tried a long list of salts, acids, and bases, organic and inorganic. Nothing especially noteworthy resulted from these experiments.

By this time we had been operating or experimenting nearly three months, all the time at high tension. I had exhausted myself of ideas, likewise the entire mill-crew, and every visitor to the mill. I pressed everybody for suggestions, talked bubbles all day and dreamed bubbles all night. It certainly seemed that we had left nothing undone that should have been done. I must admit that the extraction had been improving gradually. The froth was making a better selection of material, but was still high in silica, voluminous and difficult to handle. Our endeavor was to produce less froth with more mineral, intensive as well as selective flotation. Exhausted of ideas, we drifted along a few days, when to our great surprise and for no apparent reason whatever, the froth so long sought appeared. The voluminous tough and silicious froth had given way to a thin heavily-laden froth with the greenish-yellow cast of the pyrite. Simultaneous with it the extraction went up and the silica down.

When the extraction increased to 92%, which exceeded our expectations, we felt more kindly toward flotation, even to the extent of trying it on ores that were being cyanided. For seven days we ran flotation and cyanidation side by side on the same ore with an extraction of 96.2% for cyanidation and 96.5% for flotation. This was a surprise from which we have not yet fully recovered.

Suspending cyanidation, we applied flotation to all the different ores we could muster to the mill. The results were so gratifying, cost and extraction considered, that cyanidation was abandoned.

For the four months ending July 31, the extraction by months has been 95.01, 95.06, 95.5, and 95.6%. Extraction by metals: gold, 97.35%; silver, 82.2%; copper, 93.1%; lead, the few assays would indicate about 95%; zinc, no assays. The extraction of the silver, though considerably higher than in cyanidation, is still unsatisfactorily low. This is contrary to the impression so gen-

*M. & S. P., July 29, 1916.

eral that because a mineral floats off the table it is amenable to flotation. Silver floats off the table to a greater extent than copper, yet the flotation machine removes a greater percentage of the copper than of the silver. Figures from four months operation show a recovery on tables, copper 64.3%, silver 63.9; on the flotation machine, copper 81.1%, silver 50.7%. This extraction by concentration and flotation compares favorably with the best cyanide practice under the most favorable conditions, and when viewed in the light of the wide range of ores treated it is surprising. I am including a table made from assays of lots sampled, giving a general idea of the range covered.

I have had a keen desire to know what was at the

ence, speed, baffle, though regularly we use no baffles, none of which interfered with the extraction, that is, noticeably so. The problem of going backward we found as difficult as previously it was to go forward, though beset with much less worry.

I believe that oil, temperature, speed, etc., each has its own influence on the extraction, but within wide limits can be measured in fractions of 1%. I believe our greatest trouble was due to accumulated slime—colloidal slime if you like. Tests not yet complete seem to show that not the absolute amount of slime, but the proportion of slime, is the disturbing element.

At present the salient features of the process are:

Ore: Pyritic, containing gold and silver, with small

No.	Gold, Oz.	Silver, Oz.	Copper, %	Lead, %	Gangue	Concentration ratio about	Remarks
1	0.14	1.84	..	2.0 ±	quartz	10 : 1	
2	0.18	11.60	trace	trace	feldspar	4 : 1	
3	2.50	7.50	2.0	1.5	quartz	3 : 1	Gray copper
4	1.72	6.88	3.0	..	feldspar	2 : 1	
5	0.74	0.58	..	..	quartz	40 : 1	Free milling
6	0.40	12.20	1.4	..	feldspar	12 : 1	20 years on dump
7	0.62	4.40	..	..	talc	10 : 1	40% saved on tables
8	2.06	0.40	none	none	quartz	2 : 1	
9	1.96	1.30	1.0	0.5	feldspar	5 : 1	Mostly free milling
10	1.05	20.50	1.9	8.0	quartz	3 : 1	Chalcopyrite

bottom of our three months' troubles, and to this end have carried on the operation under different conditions as to oil, temperature, consistence, etc. In practice we are using crude wood-creosote, 15%, and a Wyoming gas-oil, 85%, this being one of the best two combinations found in the laboratory tests. We ran 10 days on wood-tar oil and gas-oil; 10 days on crude turpentine mixed with coal-tar creosote; 2 days on pine-tar and creosote with gas-oil; 2 days on pine-oil with gas-oil; and 3 days on wood-creosote with coal-oil, in all cases getting the same high extraction. During our early efforts to find the right combination of oils we would make a mixture of this, that, and the other oil, try it for 12, 15, or 24 hours as indications suggested, and that not used in the trial was thrown into a slop-barrel. In this way we accumulated a barrel or so containing every conceivable oil on which we could lay hold, organic and mineral, with some organic acids, such as oleic. Running short of other oils one day, we had recourse to this slop, which proved as efficient, entirely so, as any other oil used.

As to temperature, one day during a particularly cold snap, we had occasion to stop the machine for a short time, during which ice of considerable thickness formed over the entire machine. When we started again it was necessary to break the ice to remove the froth, yet the froth was never more heavily laden with mineral than at that time.

To test the influence of consistence, we allowed the entire mill flow, battery-water, table wash, and all to run through the machine for three days. The oil consumption might have been heavier, but the extraction was not impaired.

Many other changes were made involving submerg

amounts each of copper, lead, and zinc, concentrating anywhere from 50:1 to 2:1.

Oil: Wood-creosote 15%, Wyoming gas-oil 85%. Much trouble was experienced in feeding the oil, due to the separation of tar, closing the openings of the vessels. To obviate this I devised a feeder with a rotating cylinder with impressed cups. One can be made easily by filling the central part of a plug-valve with metal and fixing with shaft as shown in sketch. This has been working quite satisfactorily.

Consistence: 4 or 6:1.

Temperature: That of the mill.

Screen test: minus 60. The grinding is more for the purpose of liberating the sulphides from the gangue than for preparing the liberated sulphides for flotation. The machine will handle a surprisingly coarse product if it follows good table concentration.

Speed: 1100 r.p.m.

No acids or other reagents are used.

The froth is small in volume, about $\frac{1}{2}$ in. thick, covering but one-third of the froth-cell. It is removed by revolving scrapers made of 20-mesh battery-screen. The screen-openings are small enough to prevent the froth passing back, but large enough to pass the slime, thus reducing the silica in the concentrate.

ELECTRICAL transmission in mine machine-shops is becoming more general on account of its flexibility, cleanliness, freedom from noise, efficiency, and economy. Most machines are fitted with individual motors, but care must be exercised in doing this, or the motor losses may become too heavy. It is often more economical to motor groups of machines on one shaft.

Mining Decisions

MINER'S LIEN—WATCHMAN, NOT ENTITLED TO

A person employed as a watchman and to collect accounts due a mining company is not entitled to a lien for his wages under the laws of Oklahoma.

Hunt v. Stirling (Oklahoma), 157 Pacific, 741. May 2, 1916.

CONVEYANCE BY CO-OWNER—FRAUD

A deed from a part-owner of mining property to his co-owner with whom he was on unfriendly terms, is not subject to rescission merely because the grantee concealed from the grantor results of development work that increased the speculative value of the property, but disclosed no new or different conditions from those already known to the grantor.

Richardson v. Heney (Arizona), 157 Pacific, 980. June 2, 1916.

OIL AND GAS LEASE—HELD MERE OPTION

An oil and gas lease providing royalties or rentals in lieu thereof was held to be a mere option where the lessee never went into possession of the land and void if no rights were exercised thereunder within a period of two years. A formal release by the lessee as a condition precedent to relief from liability for rentals was held unnecessary.

Morton v. Drosten (Missouri), 185 South-western, 733. May 2, 1916.

GAS LEASE—RENTALS IN LIEU OF DRILLING

A gas lease by its terms required the lessees either to drill wells and pay royalties on their output, or in lieu thereof to pay stipulated rentals. The lessees paid the rentals but failed to drill any wells. The territory having been proved through neighboring wells, the lessors brought suit for damages in the amount of loss in royalties resulting from the lessees' failure to drill and the consequent draining of the land through adjacent wells. Held, no recovery could be had. The covenant for rentals operated in satisfaction of all claims for royalties, the lessors having accepted the rentals tendered thereunder. The lessors' remedy for the lessees' failure to drill would have been to terminate the lease by forfeiture after due notice to commence work. Not having availed of that remedy, he cannot sue for damages.

Carper v. United Fuel Gas Co. (West Virginia), 89 South-eastern, 12. May 16, 1916.

BOUNDARIES—MEANDER RULE APPLICABLE TO MINING CLAIMS

The plat and field-notes on which a survey for a mineral patent was based are admissible in evidence to explain the descriptions in the patent. A meander line is a line run in the survey of particular portions of the public domain bordering on a stream or other body of water, not as a boundary of the tract surveyed, but for the purpose of defining the sinuosities of the bank of a shore of the water, and as a means of ascertaining the quantity of land within the surveyed area subject to sale. The shore or bank itself is the real boundary. This rule of meander lines is now held to apply to mining claims and the courses and distances shown in the patent of certain lode claims on the shore of Gastineau channel in Alaska were disregarded as fixing boundaries in favor of the actual line of ordinary high tide at date of survey. Land to the seaward of this line which has been filled in by artificial methods is not open to mineral location.

Alaska United Gold Mining Co. et al. v. Cincinnati-Alaska Mining Co. et al. (Land Department) Decision of Secretary of Interior, April 18, 1916. (Not yet reported.)

Book Reviews

CONCENTRATING ORES BY FLOTATION. By Theodore J. Hoover. Third edition. P. 320. Ill. index. *The Mining Magazine*, London, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$3.75.

In his preface to this imprint, which is 60 pages longer than the previous one, the author states that "the advance in the use of flotation processes has been remarkable, and a very considerable part of this advance has been due to the general diffusion of knowledge * * * by the circulation of the first and second editions." The text of the second edition has been re-published intact, even leaving, on page 190, the erroneous remarks concerning the flotation of bornite and chalcocite ores; likewise the measure of surface tension per "square" centimetre. The additional matter covers the period 1914-1916. In this, excessive attention seems to be given to the Everson patent. Brief mention is made of the status of pending litigation. The theories propounded on the electro-statics of flotation are deemed unsatisfactory, while a great deal of what has been written about viscosity is termed "nonsense." Discussing surface-films and contact-angles as investigated by G. D. Van Arsdale, Mr. Hoover states that H. L. Sulman and H. F. K. Pieard have for years studied this problem, and have voluminous notes ready for publication. These, however, are in the archives of the Minerals Separation company, who are acting as "censors." About this Mr. Hoover writes forcibly, advising the patent-owning company to be frank with its probable customers. Tabulated results are given of the Horwood and Lyster selective processes as used at Broken Hill. The Callow process, so extensively used in America, is given 4 pages, the M. S. 30 pages, all others 55 pages. An incomplete list is given of users of flotation systems. Out of an average of one patent per week during two years, Mr. Hoover says that "one gropes hungrily through this huge mass for a really new idea." He gives a list of the later patents. Certain gold ores in this country are now being treated by flotation on a large scale, yet the matter is dismissed in a few lines. The notes on oils and soluble frothing agents have been presented better in recent technical journals. Twenty-two pages are added to the previous 54 pages of bibliography, making the references fairly complete. In short, this is a reprint, without revision, of the previous edition, together with 60 pages of additional matter.

M. W. von B.

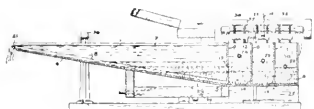
STEAM POWER. By C. F. Hirschfeld and T. C. Ulbricht. Third edition. P. 420. Ill. index. John Wiley & Sons, New York, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$2.

While essentially an elementary work on the steam engine and accessories, for colleges and technical schools, power-plant engineers will find it of value on many points. The matter is up to date, including as it does notes on the latest boilers, stokers, and turbines. The physical conceptions and units, and discussion on steam are well given. Various types of engines are described. Combustion is explained in a practical manner, also recovery of waste heat. The illustrations have been well selected. Altogether, the book will be found worth the price.

BOLETIN DEL PETROLEO. Organo de la Secretaría de Fomento. Office, 2 A Calle de Tequila No. 7, Mexico City. A. G. Perez, administrator. Price P18 per annum, or P10 per half-year. Issued twice a month. This is an official publication dealing with the oil industry of Mexico. The August number consists of 112 pages, with illustrations and statistical matter. Those interested in the work in the Tampico and Tuxpan districts will find some useful notes.

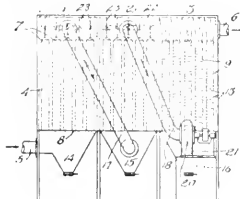
RECENT PATENTS

1,184,240. ORE CONCENTRATOR AND CLASSIFIER. Frederick N. Hubbell, San Francisco, Cal., assignor to David R. Carrier, San Francisco, Cal. Filed Sept. 8, 1914. Serial No. 860,802.



A classifier and concentrator comprising a shaking pan having a sloping bottom and side-walls forming a stratifying compartment and a plurality of collecting and discharging compartments beyond the stratifying compartment, the compartments being separated by transverse partitions, said partitions having ports at their lower ends, the vertical dimensions of said ports decreasing progressively away from the stratifying compartment, separate discharge conduits connected to the collecting compartments at progressively lower levels, and receiving means connected to each discharge means adapted to maintain a hydrostatic head in the conduits corresponding substantially to the hydrostatic head in the pan.

1,184,006. METHOD OF PURIFYING GAS. Carlton F. Moore, Salt Lake City, Utah, assignor to United States Smelting, Refining & Mining Company, a Corporation of Maine. Filed December 17, 1913. Serial No. 807,226.



1. The method of purifying the dust laden gases from ore treating and other furnaces which consists in passing the gases successively through a series of filtering fabrics, the final fabric of which is impregnated with dust preparatory to filtering use, and periodically removing the accumulation of dust from those fabrics only which precede the final fabric.

2. The method of purifying gases from ore treating the other furnaces to obtain an impurity free gas, comprising continuously passing the gases successively through a series of moveable filtering walls which become periodically impregnated and clogged with dust for removing the bulk of the dust and finally passing the gases through a quiescent dust impregnated filtering means for removing the last portion of dust.

1,192,731. RECOVERY OF NICKEL FROM ITS ORES. Henry Livingston Sulman and Hugh Fitzalis Kirkpatrick Picard, London, England, assignors to The Madagascar Minerals Syndicate, Limited, London, England. Filed Feb. 18, 1914. Serial No. 819,555.

1. The herein described process comprising precipitating nickel from a solution of nickel and other sulfates obtained by treating nickel silicate ores containing magnesium with sulfuric acid, crystallizing out a quantity of magnesium sulfate from the super-natant liquor, converting the magnesium sulfate into magnesium chlorid and a soluble sulfid,

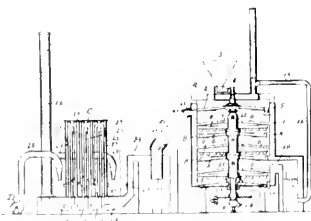
dissolving the magnesium chlorid and the sulfid products in water, and adding the solution thus obtained to a fresh quantity of the solution of mixed sulfates, for the purpose described.

1,191,848. RABBLE-ARM. Harry H. Stout, New York, N. Y., assignor to General Chemical Company, New York, N. Y., a Corporation of New York. Filed Dec. 4, 1913. Serial No. 804,559.



1. In combination, a double-walled shaft, a rabble arm comprising external and internal pipes, the internal pipe being of a diameter greater than the radius of the external pipe and being located in and supported substantially along its entire length by the external pipe, the inner end of the internal pipe being connected with the inner wall of the double-walled shaft by a telescopic joint and the delivery end of the internal pipe being located adjacent to the outer end of the external pipe, and a stop to prevent outward movement of the internal pipe as a whole.

1,195,236. APPARATUS FOR RECOVERING QUICKSILVER FROM ITS ORE. William H. Landers, New Almaden, Cal., assignor of one-half interest to Pacific Foundry Company, San Francisco, Cal., a Corporation of California. Filed Mar. 29, 1916. Serial No. 87,618.



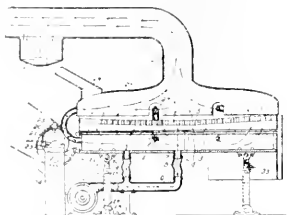
1. An apparatus of the character described, comprising a roasting furnace; a dust-settler with which the gas outlet from said furnace communicates; a condenser with which the dust-settler communicates; a stack to which the uncondensed gases from the condenser are delivered; means for subjecting the condenser to a cooling medium; and means for conducting the said medium with its absorbed heat, after it leaves the condenser, into the stack, to increase the draft through the apparatus.

1,194,669. CONCENTRATING RADIUM ORE. Herman Schlundt, Columbia, Mo. Filed Feb. 21, 1916. Serial No. 79,758.

1. The method of producing radium concentrates from carnotite ores and other suitable radium containing material, which comprises treating the material with a suitable solvent to dissolve the radium, together with barium, as sulfates, diluting the resulting solution and thereby precipitating the radium-barium sulfates in a finely divided condition in admixture with the undissolved material, and separating the

finely divided radium-barium sulfates by a differential sedimentation.

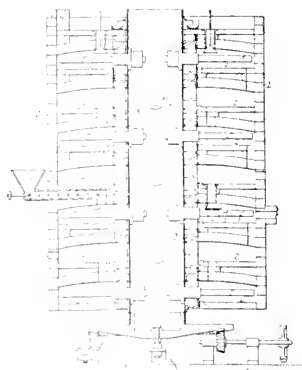
1,194,477. ORE-CONCENTRATOR. Louis David Chevalier and Henry Charles Reche, Dubuque, Iowa. Filed Dec. 27, 1915. Serial No. 68,791.



1. In an apparatus of the character described, an oscillatory reticulated table, means for forcing air upwardly through its reticulations and other means for creating opposed horizontal air currents over the upper surface thereof independent of those passing through the reticulations.

2. In an apparatus of the character described, an oscillatory table adapted to receive ore concentrates, separated means for forcing air currents vertically through said concentrates and also in opposed horizontal currents, independent of those which pass vertically through the concentrates, across its upper surface, and an inclosure for said table provided with an air delivery port.

1,195,424. FURNACE. Utley Wedge, Ardmore, Pa., assignor to The Furnace Patent Company, Philadelphia, Pa., a Corporation of Pennsylvania. Filed Jan. 20, 1910. Serial No. 539,134. Renewed Jan. 20, 1916. Serial No. 73,210.



1. A roasting or like furnace having primary and secondary heating members, means for preventing flow of gas from one heating member to the other, means for effecting the discharge of gas from each member independently of the other and a mechanical conveyor for delivering a regulated supply of reagent to the material under treatment in the secondary heating member of the furnace.

2. A roasting or like furnace having a plurality of superposed hearths, one of the hearths in the upper portion of the furnace being chambered, means for admitting air to said chamber, and means for conveying the air heated in its passage through said chamber to a treating chamber in the lower portion of the furnace.

1,193,680. RECOVERY OF ZINC. Charles H. Fulton, Cleveland, Ohio, assignor to David B. Jones, Chicago, Ill. Substitute

application Serial No. 878,573, filed Dec. 24, 1914. This application filed Dec. 23, 1915. Serial No. 68,383.

1. The herein described method of recovering zinc from zinc-bearing ore, consisting of grinding and calcining the ore, mixing it with pulverized coke in quantity more than sufficient for the reduction of metallic oxides in the ore and with a carbonaceous binding material, forming said mixture into briquets under pressure, heating said briquets to a temperature sufficiently high to destructively distill and coke the carbonaceous binding material, but not high enough to volatilize the zinc content of the ore, to form a briquet capable of withstanding without disintegration zinc-distillation temperatures; and subsequently subjecting the briquets to the usual zinc distillation process to recover the zinc.

1,193,953. HYDRAULIC CONCENTRATOR OR CLASSIFIER. Frank F. Wagner, Denver, Colo. Filed June 29, 1915. Serial No. 36,918.



1. An hydraulic plant concentrator or classifier comprising a number of tanks disposed one above another and in communication with each other, each tank except the lowermost being open at the top for overflow purposes, hoods fitted over the top of the same and forming troughs for catching the overflow therefrom, the top of each hood being provided with an opening, means for connecting the lower extremity of the tank next above with said opening, an outlet connected with each hood, and a valve located in each outlet except the uppermost for regulating the discharge and for controlling the flow of water to the tank directly above.

1,183,172. PROCESS OF ROASTING ZINC-BLENDE. Charles A. H. de Saulles, New York, N. Y. Filed Oct. 17, 1914. Serial No. 867,047.

The method of treating zinc blende for recovering metallic zinc, which comprises roasting the blende, adding carbon to the roasting charge at the latter end of the roasting operation and regulating the air admission so as to produce a temperature not exceeding 1000° C. and thereby obtaining a reduction and dissociation of the sulfates present without volatilizing any of the metals, and finally treating the resultant roast in a suitable furnace to reduce the zinc to a metallic state.

1,195,655. TREATMENT OF ALUMITE AND THE LIKE. Howard F. Chappell, New York, N. Y., assignor to Mineral Products Corporation, New York, N. Y., a Corporation of Maine. Filed Sept. 23, 1913. Serial No. 791,288.

1. The process of treating alum, alum-stone, alum-rock and alunite, which comprises submitting the same, in a reducing atmosphere, to a temperature sufficient to convert substantially all of the potassium compounds contained therein into potassium sulfate, and substantially all of the aluminum compounds into insoluble aluminum oxide and thereupon lixiviating out the potassium sulfate; substantially as described.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

BUTTE, MONTANA

EFFECT OF POSSIBLE RAILROAD STRIKE.—WAGES.—TUOLUMNE, EAST BUTTE, BUTTE & SUPERIOR, DAVIS-DALY, ANACONDA.

Preparations have been made to operate all the mines as long as possible in case any threatened railroad strike eventuates. The Anaconda company transports its ore 28 miles by rail. With this company it is a question of bin capacity. Electric power generated by water is used, so that a shortage of coal would not affect operations seriously. At the present rate of production the bins would all be full in 48 hours. At the North Butte conditions are similar, save that hoisting with steam is done at one shaft and a supply of coal will have to be stored. The East Butte is dependent on the railroads for coal, and for limestone that is used for flux. There will be no difficulty in getting ore to the smelter, as it is only a few hundred feet from the shaft. The Elm Orlu mine of the Clark interests ships ore by rail to its concentrator, and could only work until the mine ore-bins became full. Steam power is used at the mine, and a shortage of coal would also cause a shut-down. At the Butte & Superior steam power is used only for hoisting. All the coal bins are kept full, and a large supply has been stored along the railroad track. The company sends its zinc concentrates to smelters in Kansas and Oklahoma. After the railroad cars on hand are loaded and the concentrate bins are full, the mill products will be stored as long as possible. In spite of all precautions it will be necessary to stop hoisting ore at most of the mines two days after any strike became effective, and within ten days all the mines here would be closed. Development and repair work could be done at those mines that are equipped with electric hoisting apparatus, or where a supply of coal is on hand, but no provision can be made to store ore after it is hoisted.

The pay-roll of the mining companies in Butte for August amounted to nearly \$2,500,000. Wages are paid on a sliding-scale, depending on the price of copper. When the average price for a month is above 25c. per pound the miners receive \$4.50 per day, and the office employees who get less than \$300 per month are granted an increase of 10% of their salaries.

The Tuolumne company has an option on the Butte Main Range property and has finished enlarging and re-timbering the shaft from the surface to the 700-ft. level. A narrow vein of high-grade copper ore has been opened. Shipments will be made to the Anaconda smelter, and until a railroad spur is built to the mine it will be necessary to haul the ore about one mile with teams or motor-trucks.

Developments in the lower levels of the East Butte are encouraging. The output has been steadily increased since the first of the year and the company has been earning a profit of \$200,000 per month. By January, 1917, there will be a surplus of \$2,000,000, and it is rumored that dividends will be started at the rate of \$2 per annum.

About 2000 tons of ore daily is being hoisted through the old shaft of the Butte & Superior. One of the new shafts is handling men and timber to the 1500-ft. level. A new steel head-frame 135 ft. high has been erected at this shaft and a large electric hoist is being put in place. Ore will be hoisted through this shaft in 7-ton skips by about January 1. New crushing equipment is being installed at this shaft, and when it is finished an accident in one shaft will not affect the production of zinc ore. A new dry, or chance-house, made of galvanized iron, has been erected near the new shaft.

Favorable developments at the Davis-Daly are attracting attention. The company is hoisting all the ore that the present equipment will handle, and the new hoist that is being installed will soon be ready. Davis-Daly owns the mineral rights to much of the ground on which the city of Butte is built. Recently a great many frame buildings were torn down to make room for more permanent structures, and excavation for the basements of these buildings have disclosed the apex of several veins, some of which warrant prospecting at depth.

The Anaconda company publishes a monthly magazine, called *The Anode*, that has for its object the fostering of a spirit of 'safety-first.' It is a difficult task to make a publication of this kind interesting, but with its articles, cartoons, and pictures the paper fulfills all requirements. The cartoons and pictures illustrate safe and unsafe methods of performing the various duties of miners. A prize is awarded each month for the best article submitted, and as a rule there are several good ones. Interest in the various first-aid teams is kept up by accounts of their performances and records of their contests. A prize of \$750 is awarded each year to the foreman who has the least number of accidents occurring to men under his charge. The publication shows in chart form how each foreman and his assistants are running. Diagrams give data on the accidents at all the reduction works that the company controls. *The Anode* fulfills a two-fold purpose: by avoiding accidents the miners are saved suffering and perhaps death, and the company saves money as nearly all of its employees come under the workmen's compensation act.

JOPLIN, MISSOURI

ZINC-LEAD ORE SITUATION.—SURPLUS STOCK OF CONCENTRATE.—DEVELOPMENT IN OKLAHOMA.—NEW MILLS.—CONVEYOR FOR TAILING.

Weak ore markets that put a decided check on the steadily increasing development of this district caused many mines to be closed and created a disturbing surplus of ore stocks held in local bins, is the disappointing record of the month of August. It may be said, also, that immediate prospects are not very encouraging. The average basis price for blende during the month was \$58.75. This is presumably about \$2 above the average settlement price, and when it is considered that the cost of wages, powder, and general mine supplies is much greater than formerly, and that many thin-ground mines have been opened, it is evident that many must be operating at a loss, or, at least, merely breaking even and continuing to operate only with the idea of keeping intact their working organizations, so as to be able to take advantage of better prices if they should come.

The biggest problem for local producers just now is the great surplus of zinc concentrate. This was variously estimated on the first of September at between 18,000 and 24,000 tons, the larger part of which is held in the Oklahoma portion of the region. This surplus has nearly all accumulated in the past seven weeks also, and comes not so much from increased production as from decreased buying. For several weeks some of the smelting companies have been out of the market altogether, while others have been purchasing only a small proportion of their ordinary demands. The menace of the surplus, which is greater than any previous one recorded in the region, became so oppressive that a meeting of mine operators

was called in the latter part of the month to meet at Webb City and discuss whether a general shut-down should be attempted. The meeting was well attended, there being representatives from most of the centres, but it was the general opinion that no united suspension should be tried, but that individual mine-owners who could do so without too great loss should close for the best interests of the district. Since this meeting a number of the larger mines have stopped work.

Unquestionably the lightest production for many years would now be recorded in this district, due to voluntary shut-downs, were it not for the wonderful development in the Oklahoma districts. Most of this work was begun early in the spring, when prices and prospects were exceptionally good, and there is no disposition to criticize the mine owners who are now adding so materially to the regional output, but it is a fact that it comes at an unfortunate time. The greater part of this large output comes from Picher and immediate vicinity. The Eagle-Picher Lead Co. has four mills producing large quantities of concentrate. The Netta, the latest of this company's mills to start, has a capacity of 1200 tons of ore in 20 hours, and the four plants are now yielding concentrate around 300 tons per week.—Just south of the Picher mines is a new centre called Century, which is the home of what is commonly conceded to be the most remarkable zinc mine yet opened in this field. It is owned principally by investors from Canada, and is known as the Montreal mine. A recovery of better than 75% blende was made from the first 1000 tons of ore mined, with only hand jigs for cleaning. Some 300 tons of free ore, with fragments ranging in size from that of a baseball to as large as a bucket, were taken out within two weeks after the orebody was cut in the first shaft.—A short distance from this remarkable mine the Lucky Kid company's new mill has just been placed in operation, and is making from 15 to 20 tons of concentrate daily.—Near it is the Underwriters Land Co., which has just started a new mill, and is making as high as 24 tons of concentrate per day.—The Admiralty Zinc Co., also in this new centre, has two mills at work, and will have a third going in a short time.—Across Tar creek, at Cardin, the Blue Goose and Beaver mines continue their remarkable production. These mines are owned by the Commerce Mining & Royalty Co., which has been holding for higher prices. At last reports there was 2500 tons of surplus in the bins at the Blue Goose and 1500 at the Beaver.—It is a safe estimate that the production of the Oklahoma section of the region has increased by one-fourth, and probably by one-half, in the past two months. So rich are so many of the properties that active drilling continues at a high rate, and more splendid prospects are being reported almost daily, despite the slump in general market conditions.

Continued dry weather has helped to keep production down. Half a dozen of the larger sheet-ground mines of West Joplin, with more than that number in the Prosperity section of Webb City-Carterville, have been unable to operate for several weeks owing to a lack of water for wet concentration. Among these plants are included the four properties of the A. W. C. Co. at Joplin, and the Tom Coyne and Lincoln Zinc Mining & Smelting Co.'s plants at Prosperity.

The most important new plant outside of the Oklahoma field is that of the Coahuila Mining Co., at Duenweg, Missouri. This company has built No. 3 mill just south of the No. 1, which is one of the largest in the district. Since it was started in the last week of August it has been treating 1800 tons of ore per day, and making more than a carload of concentrate. The plant is equipped with skips for hoisting, as is the No. 1 mill, and there are five 150-hp. boilers.

The A. R. G. company has completed a new 350-ton concentrating plant east of the Coahuila tract at Duenweg, but as yet has not been able to start it on account of lack of water.—The St. Regis company, which has just completed a new 300-ton mill at Chitwood, is experiencing the same difficulty, and is sinking its mill shaft in an effort to remedy the trouble.

The St. Regis No. 1 mill at Duenweg is operating at full capacity and making 120 tons of concentrate weekly.—The D. C. & E. company has started its No. 2 mill in the Oronogo bottoms north of Webb City. The mill has been built for 375 tons' capacity per shift, but in such a way that this quantity can be doubled later on.—The locally noted Cramer mill at Cave Springs has been sold and will be moved to a property near Miami.—The West Virginia company has re-built the old Durston plant at Galena and started working it once more.

For the first time in this district a belt-conveyor has been installed and worked. At the old Rabbittfoot property, west of Joplin, the Blatchley Mining Co. has been treating tailing and has not been able to get enough to keep its new mill busy. A steam-shovel was considered, but finally it decided on a belt-conveyor. It is a 16-in. belt, and carries its load 130 ft., and is able to deliver the tailing at the rate of 500 tons in 10 hours. An ordinary drag-scraper or skip, steam operated, is used to bring the tailing to the hopper under which the belt is loaded.

Although market conditions are not at all encouraging just now, few of the operators are really seriously discouraged. Profits during the winter and spring were greater than ever before, and a return to good conditions in the near future is generally expected.

TORONTO, ONTARIO

FOREST FIRES.—LABOR AT COBALT.—POWER FOR KIRKLAND LAKE.
NICKEL CONTROVERSY AND POLITICS.

Additional forest fires have been raging in Northern Ontario, resulting in further loss of life and property. The mining districts generally escaped, but the Casey-Cobalt plant was destroyed.

Serious disputes over wages and labor conditions at Cobalt, which have prevailed for some time, resulted in an appeal to the Canadian Department of Labor, which was asked to appoint a board of conciliation. This was found to be impracticable, owing to a want of organization among the mine-owners, which would have necessitated the appointment of a separate board for each mine involved. As an alternative, the Department has constituted a royal commission to enquire into a report on the questions at issue, consisting of Judge Coatsworth of Toronto, A. F. Corkill of Copper Cliff, and Joseph Gibbons of Toronto.

Development at Kirkland Lake is considerably hindered until electric power can be supplied by the Northern Ontario Light & Power Co. from Cobalt. This will not be before November. Production continues by steam power at the Tough Oakes, whose July gold yield was \$88,000 from 3700 tons. An ore-shoot 120 ft. long, of good grade, has been opened on a vein recently cut on the 200-ft. level.

The nickel question still occupies a large share of public attention. The result of a by-election in south-west Toronto, decided on August 21, is regarded as significant. After a hot campaign, in which the action of the Canadian and Ontario governments in permitting the export of nickel ore to be re-fined in the United States was made the leading issue, the Liberal candidate who opposed the Government mainly on this ground, was returned by a majority of 663, in a constituency which at the previous election went Conservative by a majority of 3763 votes. Public opinion has been greatly stirred up by the *Deutschland* affair, and the general belief is that her nickel cargo was the product of Canadian mines.

The Ontario government has given the British Canadian Nickel Co. a lease of water-power rights on the Wahnapiatae river for the purpose of developing electricity. The company, which owns a nickel mine at Copper Cliff, proposes to spend several million dollars in establishing a nickel refinery, using the electric smelting process.

A 150-ton mill is contemplated for the West Dome mine, where development has been very satisfactory.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

FAIRBANKS. On August 25 the Government held a land sale at Nenana. Fairbanks people purchased most of the lots. There were 133 lots sold, realizing \$100,600. Nenana will be an important station on the new railway.

JUNEAU. After returning to Boston from a recent trip to the Alaska Gold Mines property, the president, Charles Hayden, said, "summing the whole situation up, it is fair to say that the results up to date have been somewhat disappointing but viewing it in the light of the more perfect information we now have, the financing, development, and equipment of the property on its present showing and the present extent is fully justified from every view-point, and the same people who have been responsible for these things would do the same thing if they saw the property as they see it today, instead of as they saw it in the beginning."

The August output of the Alaska Gold Mines Co. was 169,000 tons averaging \$1.38 per ton. This compares with 150,493 tons of \$1.24 ore in July, and 164,800 tons of \$1.06 in June. Another locomotive is operating on No. 7 level. A larger proportion of ore has been available from No. 5 and 6 levels.

ARKANSAS

The mixture of carbonate and sulphide of zinc ores in the northern field has proved a nuisance, and treatment is difficult. A new process of separation, devised by J. R. Wilson of Marion, Kentucky, is now being tried.

ARIZONA

OATMAN. The Tom Reed company is to deepen its main winze from 1400 to 1700 ft. The large ore-shoot at the former depth is being stoped. The gold yield for August was \$65,000.



NEW BRIDGE OVER COLORADO RIVER NEAR NEEDLES, ON THE ROAD TO OATMAN.

At a depth of 58 ft. below the 200-ft. level of the Gold Key, a tole has been cut for 14 ft. averaging \$23 per ton. This mine is west of the Lexington, in the central part of the district.

The Nellie is being equipped with a compressor, engine, pump, and hoist.

MIAMI. During August the Inspiration treated approximately 490,000 tons of ore, yielding over 11,000,000 lb. of copper. Development was increased. Good progress is being

made on No. 6 level haulage drift, being driven toward the Joe Bush orebody.

The Miami Copper Co. has issued a statement covering the first half of 1916. Development covered 18,938 ft. In the Captain orebody the shrinkage-stope method has been most satisfactory. On the main orebody slicing has been started below the 420-ft. level block, ore being hoisted from the 570-ft. level. This method is also a success. The mill treated \$59,485 tons of ore averaging 2.086% copper, with 71.44% recovery. The 32,213 tons of concentrate assayed 41.8% metal. The gross copper output was 26,931,915 lb. In the plant three Chilean mills are to be replaced by two Hardinge ball-mills. With finer grinding and other improvements the monthly yield should be increased to 5,000,000 lb. Three Nordberg-Carels Freres Diesel engines of 1250-hp. each have been ordered. The cost of producing copper was 8.9526c. per lb. The profit was \$3,499,740, of which \$2,054,564 was paid in dividends.

MORENO. It is stated that I. W. W. agitators have made themselves a nuisance here recently by making foreign laborers commit acts of near violence.

CALIFORNIA

Under the auspices of the California Metal Producers' Association, assisted by the State Industrial Accident Commission and the U. S. Bureau of Mines, the second annual California field meet for miners was held at Sacramento on September 6. There were entered 9 first-aid teams and 3 mine-rescue teams, as follows: Argonaut Mining Co., Jackson, 1; Balaklala Consolidated Copper Co., Coram, 1; Empire Mines Co., Grass Valley, 1; Kennedy Mining & Milling Co., Martell, 1; Mammoth Copper Mining Co., Kennett (mine), 1; Mammoth Copper Mining Co., Kennett (smelter), 1; North Star Mines Co., Grass Valley, 2; North Star Mines Co., Nevada City, 1; and Plymouth Consolidated Gold Mines Co., Plymouth, 1 team. Also Empire Mines Co., 1; Mammoth Copper Mining Co., 1; and North Star Mines Co., 1 team.

In the first-aid contests there were three full-team, one one-man, and one two-man events. Positions in the first event were, 1 Kennedy, 2 Empire, 3 Argonaut, and 4 Mammoth. Prizes were gold medals, trophy cup and cap lamps, cap lamps, and books on first aid, respectively. In the one-man event the Mammoth captured \$10 cash and bronze badges.

The problem for the mine-rescue men was as follows: A 100-ft. tunnel, half open so that spectators could see the actions, the remainder closed, was filled with smoke and sulphur fume. The teams entered the deadly mixture, rescued a miner, emerged with him, and then gave him artificial respiration, etc. The positions were 1 Empire, 2 Mammoth, and 3 North Star. The prizes were gold medals, cup, and \$25 cash; \$25 cash, and first aid materials and bronze badges, respectively.

The contest director was Edwin Higgins, chief inspector of the Accident Commission. Prizes were awarded by the State mineralogist, F. McN. Hamilton.

ALLEGANY. Two new 5-stamp mills, one at old Tightner dump and the other at the Morning Glory mine, the latter financed by A. A. Codd of Nevada, have started crushing.

CARVILLE. On September 4 the Pacific Gold Dredging Co. launched a new boat on Coffee creek, 65 miles from Redding. The buckets are of 9-cu. ft. capacity.

GOLDSTONE. At Seebler Well, three miles away, a mill to treat Goldstone ore will be erected, a contract having been let for the first unit by M. Ballinger of Los Angeles.

GRASS VALLEY. The California mine, in the Rough and Ready district, has been purchased by K. C. Gillette for \$80,000. Machinery and lumber will be purchased. E. C. De Golyer is in charge.

JACKSON. The concrete tailing dam for the Argonaut company is finished. It is 500 ft. long, 40 ft. high, and has 13 arches, constructed on the Eastwood plan, somewhat similar to that of the Kennedy company.

NEVADA CITY. So that the sand and gravel in the South Yuba river near Humbug canyon may be washed, E. W. Kay and F. A. Elliot are to change the course of the river by carrying the water in flumes.

OROVILLE. At its Thermalito property the American Gold Dredging Co., late Oro, is to construct a new dredge. The company's other boats are some distance from this area.

(Special Correspondence).—Progress at the Old Eureka has been retarded during the past week on account of caves in the shaft, and the work of unwatering and re-timbering has reached a point only a short distance below the 600-ft. level. Little difficulty of this nature was encountered in the first 500 ft., most of the timbers being found intact; but notwithstanding the care now necessary to catch-up the loose ground, the management feels confident of reaching the 2000-ft. level early in 1917. The modern steel head-frame will have to be erected to continue exploration at depth, and grading is now being done for the concrete foundations of the new hoisting plant.

Amador county miners have evidently re-considered their threat to walk out on the 9th, as work at all the mines along the Lode continues as usual, and union officials state that they have no intention of declaring a strike.

With the exception of pumping operations, no work is in progress at the Rose or Poundstone mine a mile east of Sutter Creek. It is understood that negotiations are pending for a sale.

Sutter Creek, September 10.

COLORADO

BRECKENRIDGE. A recent transaction resulted in transferring 48 gold-bearing claims, including the Jumbo Extension, Double Extension, Mascot, Arab, Excelsior, and Dashwarren mines to Samuel Klaus of Boston. A 20-stamp mill was also part of the deal. To develop this ground the Pioncer Consolidated Mines Co. has been organized. The properties have been idle for several years. New machinery has been ordered.

(Special Correspondence).—The Roosevelt tunnel, which is being driven for the drainage of the Cripple Creek district, has now reached a point about 1290 ft. east of the Elkton main shaft. It is a little over 4 miles long to this point and 1800 ft. below the surface. The adit is about 9 ft. wide by 8 ft. high in the clear, with a ditch at one side 4 ft. wide by 2 ft. deep in the centre. During August the progress in driving was 437 lineal feet. The best previous record was 400 ft., in January 1909. During August only 27 days of 3 shifts each were worked, 8 men on each shift. The rock is a very hard volcanic breccia, with occasional dykes of phonolite and basalt, also very hard. It usually requires at least 30 holes to break a round, and 5 to 7 ft. per round is broken. Water is coming out of every fissure and crevice in the rock, and the total flow at the portal is now 10,350 gal. per minute. The men all have to wear heavy rubber clothing and boots. Little timbering is required. The rock is hauled from face by mules, and hoisted out of the Elkton shaft. The drills used are the Ingersoll-Leyner model No. 18 with 2½ in. bits for starters. Two drills on a horizontal bar are used each shift. The wedge-cut system of holes is drilled. It is intended to drive the tunnel about 6400 ft. farther to connect with the Golden Cycle shaft. The tunnel is now rapidly draining the entire district. Charles F. Fuller, a man of extensive and successful experience in tunneling, is superintendent of the work, and he has selected a

force of skilled workmen. T. R. Countryman is engineer in charge.

Cripple Creek, September 2.

GEORGETOWN. Hanson & Walthers, lessees at the Capital mine, have opened ore assaying 1190.4 oz. gold per ton. This shoot is 297 ft. above the main adit-level, and at a depth of 1200 feet.

LEADVILLE. This town has now a population of 8000, and 14,000 in the whole district, an increase of 500 in a year.

At the Western Zinc Oxide plant, where carbonate ore is treated, four new furnaces are in operation, making twelve. The plant's capacity is now 60 tons daily. Mines sending low-grade ore to the works are the Tip Top, Baby, La Plata, Robert E. Lee, Little Silver, Yak tunnel, and others. The weekly output is 50 tons of oxide containing up to 80% zinc. This will soon be 75 tons.

Ore assaying 165 oz. gold per ton has been found by Mock and Hartman in the Twin Lakes district.

TELLURIDE. Shipments of ore and concentrate during August totaled 129 carloads, mostly the latter product. This was a good month. Contributors were the Tomboy, Smuggler-Union, and Liberty Bell.

IDAHO

ADAIR. Shipments from the Richmond mine, near here, suspended last December, have been resumed, and two four-horse teams now are hauling ore to the railway at Saltese, Montana, 5½ miles away. Only the ore extracted in development is being forwarded, and two grades are being mined; the second class, averaging between 5 and 6% copper and \$10 per ton in gold, being sent to the Washoe smelter at Butte, and the high grade, running 20% copper, is going to the smelter at Greenwood, B. C. From 15 to 20 men have been employed since the beginning of the year. A fair tonnage of ore is blocked out. Charles Heidenrich is manager.

Arco. Owing to disappointing developments the Wilbert Mining Co., operating 40 miles away in the Dome district, has suspended milling. Exploration is to continue.

GEM. According to rumors circulating both at Spokane and in the Coeur d'Alene, the Tamarack & Custer Mining Co. has purchased the Frisco mill, near Gem, from the Federal company, and will take possession at once. No authoritative confirmation of the report is obtainable from either the Federal or the Tamarack & Custer managements, but the belief prevails generally that the deal, pending for several weeks, has been closed. To connect the Tamarack & Custer workings with the Frisco mill a three-mile aerial tram, traversing the divide between Nine-Mile and Canyon creeks, will have to be installed. It is said that plans for the carrier already are prepared, and that construction can begin as soon as material is assembled.

GLADSTONE. The Pittsburg-Idaho company is again paying 1½c. quarterly per share. This is equal to \$40,000. The monthly output of ore and concentrate is 2500 tons. A power-plant is to be erected.

GOLDEN. Portland, Oregon, people, headed by A. McRae, have bonded the Buckhorn mine in the Ten Mile district for \$100,000. An examination revealed 50,000 tons of \$15 ore. Development is done by four adits. The mill is to be re-modeled.

MURRAY. The placer areas adjacent to Murray are to be re-worked, after being idle for 25 years, by the Coeur d'Alene Placer Mining Co., which owns 2800 acres on Prichard creek. A dredge may be built next spring. J. S. Wyatt is in charge. Drilling is now under way.

MISSOURI

JOPLIN. At M. L. Smith's farm near Galena a drill is to prospect to a depth of 1000 ft. If ore is found there it will be the deepest in the zinc-lead region.

Ore prices were \$5 per ton weaker last week. The output

of the region was 5663 tons of blende, 211 tons of calamine, and 1180 tons of lead, averaging \$58, \$41, and \$64 per ton, respectively. The total value was \$415,100.

MONTANA

BUTTE. Work has been started at the Butte-Daluth mine, in charge of H. A. Frank.

MARYSVILLE. During August the Barnes-King properties yielded gold worth \$33,000 from 3511 tons of ore. The Riblet aerial tram, about three miles long, of 350 tons daily capacity, is working well. This carries loaded buckets up a steep incline a mile in length, and then down the remainder of the distance to the Piegian-Gloster mill.

PHILIPSBURG. Work has been resumed at the Swastika copper mine, which was closed two years ago.

NEVADA

ELY. The Coppermines company's Giroux mill at Kimberly is to be re-modeled, a contract having been let for this work. The Callow flotation system will be used in the 500-ton plant. Milling may start in three months. The Morris shaft is to be unwatered and sunk 250 ft. G. N. P. Douglass is superintendent.

GOLDFIELD. The Klondyke-Portland Mines Co. is to resume work at its property midway between Goldfield and Tonopah. Two carloads of silver-gold ore are ready for shipment.

LAS VEGAS. To handle ore from Goodsprings and other districts, J. B. Jensen is to build a sampler at Jean or Las Vegas.

(Special Correspondence.)—Pending installation of additional equipment to settle and filter the concentrate, the use of flotation has been temporarily discontinued at the Goldfield Consolidated mill. Changes in the ore must also be considered. Until more equipment is installed the company will revert to the cyanide process. It is believed that the company will be able to resume the use of flotation within 60 to 90 days. The process is entirely satisfactory on these gold-copper ores.

The west cross-cut from the 1750-ft. level of the Atlanta has entered the Consolidated lode, and is advancing in quartz assaying low in gold, silver, and copper. The work is being done in hopes of intersecting a shoot of \$30 to \$70 ore opened several months ago on the 1500-ft. level of the Grizzly Bear mine.

The Cuprite district reports considerable activity. At a depth of 300 ft. in the Rea copper mine a cross-cut is being driven to intersect the large vein disclosed at 200 ft. The mine is operated under option by W. A. Clark of Montana. —The Cuprite Sulphur Co. is shipping high-grade sulphur, and has contracted to produce a minimum of 200 tons monthly. A. W. L. Dunn is manager.

Goldfield, September 9.

NATIONAL. The National Mines Co. is to sink its shaft 500 ft. below No. 5 adit. This will result in opening the orebodies at depth and enable work to be done more economically.

NEW MEXICO

MAGDALENA. The plant of the Ozark Smelting & Mining Co. on the Graphic mine was recently destroyed by fire. Rebuilding will commence as soon as possible. Treatment was described by Philip Argall in this journal of January 22, 1916.

(Special Correspondence.)—The clean-up by the Mogollon Mines Co. for last half of August produced $\frac{3}{4}$ of a ton of gold and silver bullion and $4\frac{1}{2}$ tons of high-grade concentrate from the treatment of approximately 2100 tons of ore. The new shaft is 880 ft. deep, and has encountered andesite on both walls. Work on the company flume to convey tailing to storage-dams on Mineral creek, about 4 miles below, is being pushed and with prompt lumber deliveries will be completed this fall.

The tailing-disposal system adopted by the Socorro Mining & Milling Co., consisting of an elevator by which the mill dis-

charge will be conveyed to an adjoining flat, has been delayed by the equipment having gone astray in transit.

The Oaks Company is continuing to find good milling ore from development both in Clifton and Eberle mines, and is making regular shipments to local custom works.

The U. S. Geological Survey, through Henry G. Ferguson, is about to complete data for a geological folio of the district. A detail survey was made a few months ago, and Mr. Ferguson is now working on the geology of the properties. When completed this data will be of great value to the district.

Mogollon, September 5.

OKLAHOMA

BAXTER. Five miles west of this place, which is on the Kansas-Oklahoma line, the Blue Mound Mining Co. has put down 33 drill-holes, 23 of which in a space 500 by 600 ft., cut ore containing from 10 to 35% zinc-blende. The holes are from 204 to 280 ft. deep. Four shafts are to be sunk. The United Iron Works is to build a 400-ton mill, etc., costing \$50,000. The Eagle-Picher Lead Co.'s property adjoins.

TEXAS

(Special Correspondence.)—The West Texas Sulphur Co., which is composed of New Orleans, Louisiana, men, is preparing to exploit extensively the large sulphur deposit in the Toyah district that it acquired some time ago. The company's holdings embrace 600 acres, and a number of test holes show that sulphur occurs from the surface outcrop to a depth of about 75 ft. The product is high grade and can be easily mined, it is claimed. The Michigan Sulphur & Oil Co., which owns a large sulphur deposit in Culberson county, in the same section as that of the West Texas company, recently installed the first unit of a large sulphur reduction plant, and it is now producing and shipping considerable quantities of the product. A party of Mobile, Alabama, men, headed by F. H. Edington, recently visited this section and made an inspection of the different sulphur deposits with the view of becoming financially interested in the industry.

Toyah, August 25.

UTAH

There are 114 mining districts in this State, according to the U. S. Surveyor General's report for the past fiscal year. In these there are 37 mineral surveyors. During the period there were 31 mineral surveys embracing 151 locations. The demand for surveys of claims has increased greatly in the past 18 months. The cost per location was \$18.40.

To relieve the congestion of ore at Utah smelters the A. S. & R. Co. is to double its plant at Garfield, making 800 tons' capacity per day of copper ore. To take care of lead-silver ore the Murray smelter will be enlarged, and a 450-ft. stack built.

EUREKA. V. Carlson and H. Backman, lessees on the 1400-ft. level of the Gemini mine, are shipping ore containing from 500 to 7000 oz. silver, 20 to 30% lead, and 7 to 10% copper.

GARFIELD. The new sulphuric acid plant at the A. S. & R. smelter is making good progress and should be completed by November.

PARK CITY. The Big Four Exploration Co., treating tailing on Atkinson flat, will soon be working 800 tons daily. The zinc product has been sold up to the end of this year.

On October 2 the Judge Mining & Smelting Company pays 25c. per share, equal to \$120,000. This makes \$310,000 for the year. Good progress is reported from the new smelter that is to treat 40 tons of 40% zinc ore daily.

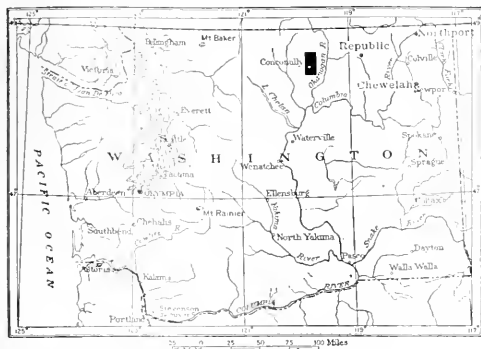
SALT LAKE CITY. Another ore-sampling plant is to be erected here. Mining interests that produce from 12,000 to 15,000 tons of ore per month are behind the project. The plant, of the Vezin type, will handle 750 tons daily, costing \$75,000.

The Ohio Copper company's property has been leased to the General Exploration Company.

WASHINGTON

Eleven mines in Stevens and six in Ferry county are now shipping ore to the Trail smelter in British Columbia. The Deer Trail, 22 miles from Davenport, is a new producer, although years ago it yielded \$750,000. The Last Chance at Republic is to be opened to a depth of 500 ft., and will be an addition to the shipping list.

The Conconully and Ruby mining districts are in the north-central part of Washington, about 40 miles south of the Canadian border. The ore deposits were discovered in 1886, but production has been small owing to lack of transportation



THE CONCONULLY AND RUBY DISTRICTS ARE SHOWN BY THE BLACK SQUARE.

facilities, difficulty in treating complex ores, and the decline in the price of silver. The most valuable ore deposits in these districts consist of quartz vein which occur in schists near the areas of granite or at the contact of schist and granite. The ore minerals, pyrite, zinc-blende, chalcopryite, and gray copper, carry silver and a little gold. A report on these districts, by Edward L. Jones, Jr., just published by the U. S. Geological Survey as Bulletin 640-B, contains a study of the geology and mineralogy of the region and detailed descriptions of the individual mines and prospects.

CANADA

BRITISH COLUMBIA

During the last week of August the Trail smelter received 15,134 tons of ore from all parts, compared with 11,487 tons in the previous week.

According to F. M. Sylvester of the Granby Consolidated, the company is always on the lookout for promising new properties. In the past year about 100 prospects were examined. Of the newer properties two now are on a substantial producing basis. The Midas mine at Valdez, Alaska, is shipping to the smelter at Anyox between 3000 and 4000 tons of ore monthly; the Mamie mine, on Prince of Wales island, between 4000 and 5000 tons. A number of others are producing on a smaller scale. This is moved through a subsidiary company owning and operating a fleet of steamers. The Grand Forks plant blew-in its seventh furnace on September 7. As the Crow's Nest Pass Coal Co. seems to have overcome its labor troubles and to be in a position to keep up a supply of coke, the eighth furnace should soon be in blast.

ONTARIO

COBALT. Silver production of the Kerr Lake mine in the first half of 1916 was 1,260,000 ounces.

To treat 500 tons of old and 1000 tons of new tailing daily, the Buffalo Mines Co.'s new flotation plant has been completed and started.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

H. H. WEBB is here.

JOHN M. NICOL is in Plumas county.

JOHN T. TOWERS is at Barkerville, B. C.

C. W. PURINGTON is expected at New York.

GEORGE WATKIN EVANS is in the interior of Alaska.

J. B. TYRRELL has returned to Toronto from British Columbia.

O. H. REINHOLT is touring in Arizona and will attend the Institute meeting.

M. M. VALERIS and V. H. MCNUTT are in New York on a two weeks' business trip.

W. S. GREYER is superintending operations at the Hudson Bay mine near Salmo, B. C.

W. YOLEN WILLIAMS of Spokane has been examining mines in the Ainsworth district, B. C.

CHARLES BUTTERS has gone to Chicago; from there he will proceed to New York and London.

E. H. WATSON has returned to the Lena district in Siberia, to take charge for the Olikma & Vitim Gold Company.

C. W. BOISE of New York has gone to the Belgian Congo, where his address is care Forminiere, Tshikapa, Kasai.

W. J. LAKELAND has resigned his position with the Burma Mines and has joined the Indian Army Reserve of Officers.

W. L. HOSKOLD has gone to New York to serve as chairman of the committee representing the Commission for Relief in Belgium.

WILLIAM TRICAN has returned to Georgetown, California, from London, having served for a year with the Ministry of Munitions.

GEORGE B. HOLDERER, recently manager for the Furlough Development Co. in Arizona, is now with the General Chemical Co., New York.

PAUL W. AVERY is visiting the principal copper mines of Arizona; he will attend the Institute meeting and then return to El Oro, Mexico.

GEORGE A. GUESS, professor of metallurgy in the University of Toronto, has been engaged to start the smelter of the Vermont Copper Co., at South Trafford, Vermont.

Obituary

BROOKE MOORE, chief chemist of the Mountain Copper Co., died suddenly at Martinez, California, on September 11. He was 38 years old, and had been with the company for 17 years.

FRANK McMILLAN STANTON died on September 12. The son of John Stanton, he had long been associated honorably with the Lake Superior copper industry, notably the Atlantic mine and the Copper Range group of companies.

When the American Chemical Society meets in New York on September 25 to 30, it is expected that with those attending the American Electrochemical Society's meeting and the Exposition of Chemical Industries there will be over 2000 chemists present. The Technical Association of the Pulp and Paper Industry will also hold sessions during the same week. The presidential address will be given by Charles H. Herty of the Society. There will be a symposium on colloids, industrial conferences, and many discussions. Chemical papers will cover agriculture and food, biology, fertilizer, organic, industrial, pharmaceutical, physical and inorganic, and water, sewage, and sanitation subjects.

THE METAL MARKET

METAL PRICES

San Francisco, September 12.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	28.75
Pig lead, cents per pound.....	6.75-8.00
Platinum: soft and hard metal, per ounce.....	\$85-\$89
Quicksilver: per flask of 75 lb.....	\$75
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, September 12.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$1.00
Chrome: 45% and over, f.o.b. cars California, per ton, 13.00-15.00	
Manganese: 50% product, f.o.b. cars California, ton.....	12.00
Magnesite: crude, per ton.....	7.00
Tungsten: 60% WO ₃ per unit.....	14.00

New York, September 6.

Antimony: The market is unchanged at \$1.10 to \$1.20 per unit, and very dull.

Tungsten: Over 450 tons has changed hands in the past few days at around \$20 per unit. For ore of special quality \$22.50 was paid for immediate delivery. Contracts have been made for October and November delivery, and the general aspect of the market is better.

EASTERN METAL MARKET

(By wire from New York.)

September 12.—Copper is firm and active, lead is quiet, but an advance is expected; spelter is firm on export enquiry.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Sept. 6.....	68.25
" 7.....	67.87
" 8.....	68.25
" 9.....	68.37
" 10 Sunday.....	68.00
" 11.....	67.87
" 12.....	68.10

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.30
Feb.	57.53	48.45	56.74	Aug.	54.35
Mar.	58.01	50.61	57.89	Sept.	53.45
Apr.	58.52	50.25	64.37	Oct.	53.12
May	58.21	49.87	74.27	Nov.	49.12
June	56.43	49.02	65.94	Dec.	49.27

The tone of the silver market is good, yielding a point or two on occasion, probably profit taking or lack of rivalry for supplies. Three weeks ago metal was sold on China account for India, thus checking the Indian demand in London and lessening competition with coinage orders. Movements of silver in England for the 7 months ended July 31 are as under:

1916.	1915.	1914.
Imports	52,399,133	53,995,002
Exports	20,150,667	19,167,991

The imports are remarkably even, but exports indicate the small quantity sent to India and the large amount retained in England for coinage.

Exports of silver from San Francisco during August totaled \$1,947,000. On September 9 metal worth \$750,000 was shipped to the Orient.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Sept. 6.....	28.00
" 7.....	28.00
" 8.....	28.00
" 9.....	28.12
" 10 Sunday.....	28.00
" 11.....	28.12
" 12.....	28.12

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	21.30	July	13.26
Feb.	14.46	14.38	26.62	Aug.	12.31
Mar.	14.11	14.80	26.65	Sept.	12.05
Apr.	14.19	16.61	28.02	Oct.	11.19
May	12.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.17	Dec.	12.75

August yields are as follows: Anaconda, 28,800,000 lb., In-

spiration, 11,450,000; Kennecott, 10,200,000; Braden, 2,616,000; Old Dominion, 3,600,000; Miami, 1,698,795; and East Butte, 1,819,120 pounds.

Old Dominion is paying \$3 per share on September 29.

The A. S. & R. Co. is to enlarge its Baltimore refinery's capacity by 120,000,000 lb. of copper per month, making the total annual output 1,080,000,000 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Sept. 6.....	6.75
" 7.....	6.75
" 8.....	6.75
" 9.....	6.75
" 10 Sunday.....	6.70
" 11.....	6.70
" 12.....	6.70

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	3.95	July	3.80
Feb.	4.02	3.33	6.22	Aug.	3.86
Mar.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

On October 1 the Consolidated Mining & Smelting Co. of Canada pays 2½¢, equal to \$210,867.—The Hecla Mining Co. of Idaho pays 15¢ per share, or \$150,000, on September 29.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Sept. 6.....	8.75
" 7.....	8.75
" 8.....	8.75
" 9.....	8.87
" 10 Sunday.....	9.00
" 11.....	9.00
" 12.....	9.12

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mar.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.93	9.78	18.62	Oct.	4.75
May	4.91	17.02	16.01	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

Exports and imports of spelter during the fiscal year ended June 30, 1916, were as follows, in pounds:

1916.	1915.	1914.
Exports	281,598,282	267,041,819
Imports	258,777,101	11,251,858

Total

540,375,383	278,293,672	25,954,805
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American Zinc, Lead & Smelting Co.'s profits for 7 months were \$1,592,000.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending	1914.	1915.	1916.
Aug. 13.....	71.00	77.00	77.00
Aug. 22.....	72.00	77.00	75.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	22.00	July	37.50
Feb.	39.00	60.00	23.00	Aug.	38.00
Mar.	39.00	78.00	21.00	Sept.	36.25
Apr.	38.50	77.50	141.60	Oct.	32.00
May	39.00	75.00	90.00	Nov.	35.00
June	38.60	90.00	74.70	Dec.	33.10

TIN

Prices in New York, in cents per pound.

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	31.40	11.76	July	31.60
Feb.	39.76	37.23	12.60	Aug.	30.20
Mar.	38.10	43.76	50.50	Sept.	32.10
Apr.	36.10	48.25	51.43	Oct.	30.40
May	33.29	39.28	49.10	Nov.	33.51
June	30.72	10.26	42.97	Dec.	33.60

Tin is steady at 38.25 cents.

During the quarter ended June 30 the Vulcan Detinning Co. made a loss of \$8566. Sales totaled \$181,981. In six months the profit was \$11,982. The surplus is \$112,331.

Eastern Metal Market

New York, Sept. 6.

The entire metal market was adversely affected by the threatened railroad strike. During the uncertainty consumers had no inclination to buy. The quietness was continued by the Labor Day holiday.

Copper continues in a strong position, the scarcity of spot being so great that premiums are again near. The Allied governments are certain to buy millions of pounds for 1917 delivery, but so far price has been the obstacle to business in that direction.

The larger producers of zinc are well filled with orders, and the recent fluctuations of prices has been due to second-hand operations. Until the strike scare a good business was done. Prices are lower.

Many consumers of lead are short, and have been obliged to buy at advanced prices. With all producers well sold up, outsiders have obtained some fancy profits.

Consumers are showing little interest in tin. Their temper is not good for the reason that they are now taking deliveries of metal for which they paid more than prices now ruling.

Antimony is dull and easy.

Aluminum is strong at 60 to 62 cents.

The total of pig-iron production in August was 3,203,713 tons or 103,346 tons per day, against 3,224,513 tons in July or 104,017 tons per day. A slight increase in active furnaces was counteracted by heat and humidity. September is expected to show a gain. The buying of steel keeps up on a huge scale, many of the mills being well sold into next year. Foundry pig-iron has been more active; its prices, while firm, show no advance. August shipments of iron ore from Lake Superior established a new record, amounting to 9,850,000 tons. It is probable that the season's shipments will exceed 62,000,000 tons. August was a good month with metal-working machinery.

COPPER

Fear that the threatened railroad strike might come and the holiday this week made the market quiet in the past few days, but it is, nevertheless, strong at 28c. for spot or September metal, 27.75c. for October, 27.50c. for November and December, and 26.50c. for first quarter of next year. Spot is so scarce that it is highly probable that up to 28.50c. might have been paid for immediate shipment. The quotations given for near-by delivery are those of outside sellers, the producers being well sold up for the next few months. Up to the time of the scare over possible strike the market was fairly active. It is unquestioned that Great Britain and her Allies must have large quantities of copper for delivery next year, but they are unwilling to meet present prices. It is reported that they have offered 25 to 25.50c. It is understood that the British government will buy 250,000 tons. For such an enormous quantity it is natural, of course, that a price would be fixed considerably lower than domestic consumers of moderate-sized quantities would be asked to pay. For small lots out of store, jobbers are today getting 29 to 31c. The London market was quoted yesterday at £130, against £129 a week previous. August exports totaled 32,160 tons, a good showing. Statistics cabled to the New York Metal Exchange, September 5, show that stocks in Great Britain and France increased 1692 tons in the last half of August, the total supply in those countries on the 31st being 7514 tons. In the last two weeks of the month the quantity afloat for Europe decreased 1200 tons. The total visible supply on September 1 was 11,514 tons, 4000 tons of which was afloat from Australia and Chile. Lake copper is nominally quoted at about the same levels as electrolytic. The demands for brass and copper products show no diminution.

ZINC

The market was hard hit by the threatened railroad strike, and has not recovered. Despite a slight show of interest on the part of domestic consumers yesterday, the market is dull and prices are easy. Prompt can be easily obtained at 8.75c., New York, and 8.50c., St. Louis, and these figures probably could be shaded. October delivery can be had at 8.25c., St. Louis, November at 8.12c., and December at 8c. The larger producers assert that they are well filled with orders for the remainder of the year, and the recent ups and downs of the market are attributed to manipulation by second-hands. In August, domestic galvanizers took large quantities of the metal and that activity was followed by good export buying. On the 31st the Board of Managers of the New York Metal Exchange adopted a new ruling as to what constitutes a good delivery of zinc on contracts for prime Western. It follows:

"Prime Western shall be virgin spelter, resulting from the distillation of zinciferous material, and shall not contain on the average in excess of 2% lead and 0.08% iron. In case of dispute, one slab out of every ton shall constitute a proper sample. Re-melted spelter shall not be a good delivery."

The reason for the change is that for some time 90% of the prime Western spelter produced has run over 1½% lead, the maximum of lead under the rule which was displaced. When Joplin ores alone were used the product did not exceed 1½% lead, and the rule was easy of adherence. Lately it has been obsolete. Exports in August reached the excellent total of 11,352 tons. The London quotation yesterday for spot was £49, against £58 a week previous. Sheet zinc, carload lots, is unchanged at 15c., f.o.b. mill.

LEAD

Like all the metals, lead suffered from the recent disturbed railroad conditions. Fundamentally it is strong. Both the leading interest and independent producers are well sold ahead, but at the same time there are important consumers whose requirements are not covered. Yesterday, the 5th, the outside market jumped to 6.75c., New York, and 6.60c., St. Louis, following the appearance in the market of consumers who were forced to buy. Good sales were made at that price, and at 6.65c., Chicago, and more could have been done if the metal had been offered. The leading interest continues to quote 6.50c., New York, and 6.42½c., St. Louis, but when it sells it deals only with customers and then only in limited quantities, according to report. The situation has given outside sellers a chance to pick up some premiums for spot deliveries. August exports were only 830 tons. The spot quotation at London yesterday was £31, unchanged from a week previous.

TIN

The business of the week, and it was not a great deal, was in futures, of which 250 tons was taken August 31. The market is easier at 38.87½c. (September 5) for spot Straits. Banca continues to be offered for spot delivery, and has been sold at 1 to 1½c. under spot Straits. The trade was disappointed by the August statistics, in that they showed deliveries into consumption in that month to be 4335 tons, whereas it had been expected that they would be much larger. They were, however, above normal. Deliveries for eight months of this year total 40,388 tons, which is 8130 tons in excess of the same period in 1915. Of the arrivals in August, 535 tons came by way of Pacific ports. The U. S. Commerce Reports (August 2) state that the A. S. & K. Co. is obtaining good results at its tin smelting and refining plant at Perth Amboy, New Jersey. Early in August about 10 tons per day was produced, and it was hoped to increase the amount to 15 tons, the largest possible output with the present equipment.

Recent Publications

FLORA OF THE FOX HILLS SANDSTONE, SOUTH DAKOTA. By F. H. Knowlton. Professional paper 98-H. P. 9. Illustrated.

GEOLOGICAL CRITERIA FOR DETERMINING THE STRUCTURAL POSITION OF SEDIMENTARY BEDS. By G. H. Cox and C. L. Dake. May Bulletin of School of Mines and Metallurgy, University of Missouri. P. 59. Illustrated. Rolla.

BOLETIN DEL MINISTERIO DE FOMENTO. Primer Trimestre de 1916. P. 566 and index. Republica Peru. Ofic. Cip. de La Opinion Nacional, Calle del Correo No. 194, Lima.

Contains sections on mines, agriculture, and other industries of Peru.

PHYSICAL CONDITIONS AND AGE INDICATED BY THE FLORA OF THE ALUM BLUFF FORMATION. By T. W. Berry. Professional paper 98-E. P. 19. Illustrated. Also PHYSICAL CONDITIONS INDICATED BY THE FLORA OF THE CALVERT FORMATION. No. 98-F. P. 13. Illustrated.

ANNUAL REPORT OF THE MINISTER OF MINES OF BRITISH COLUMBIA FOR 1915. P. 473. Ill., maps, charts, index. Government Printer, Victoria, B. C., 1916.

As usual this annual publication contains a great deal of interesting matter on mineral production.

REPORT AND TOPOGRAPHIC AND STRUCTURAL MAPS COVERING Raleigh county and parts of Mercer and Summers counties of West Virginia. P. 778. Ill., maps, index. By Charles E. Krebs and D. D. Teets, Jr. West Virginia Geological Survey, Morgantown, 1916.

This is a well-prepared work, dealing with an area containing extensive areas of coal.

U. S. Geological Survey, Washington, D. C., 1916: COLORADO RIVER AND ITS UTILIZATION. By E. C. La Rue. Water-supply paper 395. P. 231. Ill., maps, charts, index.

The proposed use of the Colorado river for water and power for Oatman and other districts of Arizona should make this useful publication of value.

CEMENT IN 1915. By Ernest F. Burchard. P. 24. Chart. PLATINUM AND ALLOYED METALS IN 1915. By James M. Hill. P. 19.

POTTERY IN 1915. By Jefferson Middleton. P. 11. SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES IN 1915. Mines report. By J. P. Dunlop and B. S. Butler. P. 93. BIBLIOGRAPHY OF NORTH AMERICAN GEOLOGY FOR 1915. By John M. Nickles. Bulletin 645. P. 114. Index.

ANTIMONY DEPOSITS OF ALASKA. By Alfred H. Brooks. Bulletin 649. P. 67. Ill., maps, index.

RECONNAISSANCE OF THE CONCONULLY AND RUBY MINING DISTRICTS OF WASHINGTON. By Edward L. Jones, Jr. Bulletin 640-B. P. 16. Maps.

THE ALASKAN MINING INDUSTRY IN 1915. By Alfred H. Brooks. Bulletin 642-A. P. 71. Maps.

MINERAL RESOURCES OF THE UPPER CHITINA VALLEY, ALASKA. By Fred H. Moffitt. Bulletin 642-C. P. 8. Map.

MINING ON PRINCE WILLIAM SOUND, ALASKA. By Bertrand L. Johnson. Bulletin 642-D. P. 9.

GOLD MINING IN THE WILLOW CREEK DISTRICT, ALASKA. By Stephen R. Capps. Bulletin 642-F. P. 6.

THE TURNAGIN-KNIK REGION, ALASKA. By Stephen R. Capps. Bulletin 642-E. P. 48. Maps.

PRELIMINARY REPORT ON THE TOLOVANA DISTRICT, ALASKA. By Alfred H. Brooks. Bulletin 642-G. P. 9. Map.

MECHANICS OF THE PANAMA CANAL SLIDES. By George F. Becker. Professional paper 98-N. P. 9. Illustrated.

Industrial Notes

Information supplied by the manufacturers.

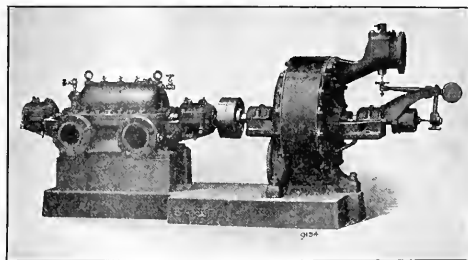
A leaflet published by the E. I. DU PONT DE NEMOURS & Co. of San Francisco gives prices of explosives in the Western States.

The BRENNAN WAHL Co. of Chicago announces that it is prepared to act as consulting chemical, mechanical, and structural engineers, and as agents for machinery and allied products.

An Improved Centrifugal Pump

Development of the steam turbine and high efficiency multi-stage centrifugal pump has progressed together, but so far it has not been entirely practicable to reconcile the speeds of the two machines so that each would work at its best efficiency. Heretofore it was necessary to reduce the speed of the turbine and sacrifice much of its efficiency or else speed up the pump with similar results. To overcome this difficulty the Cameron Steam Pump Works of New York has designed and built a multi-stage centrifugal known as the "B-T" type.

The accompanying electro shows a completely assembled



CENTRIFUGAL PUMP AND STEAM TURBINE.

pump and engine. The speed feature is a virtue of the impeller design. With the ordinary impeller the diameter cannot be reduced sufficiently to get high speed without sacrificing vane length, and consequently efficiency for a certain vane length is necessary in order that the impeller may perform its function without excessive loss. Small external diameter and adequate vane length are obtained in this pump, by bringing the vanes well down into the impeller hub, at the same time so turning them that the incoming water is guided smoothly, and with little loss into the outer portion of the vanes where the velocity is generated that is finally converted into useful pressure by means of the external diffusion vane. Additional advantages in the small impeller are light weight and low fibre stresses in the material. Each impeller is cast solid in one piece and is of the enclosed type. The casing is divided along the horizontal centre line. Both the suction and discharge connections are in the lower half of the casing. The upper half is readily removable, giving full access to the revolving element. There are suitable openings for draining the pump and for displacing the air when starting. Inlet and outlet nozzles can be arranged either on the same or opposite sides, an important advantage where pumps are installed in limited space. The shaft is made of high-grade forged steel, and wherever it comes in contact with the fluid being pumped it is thoroughly protected by bronze sleeves. To take care of thrust, which manifests itself in all multi-stage pumps, this pump is equipped with a simple internal hydraulic balancing device.

EDITORIAL

T. A. RICKARD, Editor

MILLION-SHARE days are becoming frequent on the New York stock-exchange. Optimism is rampant. But we never think of Wall Street without regretting the number of dynamic men that devote great ability and unusual energy to the game of the ticker and the tape instead of being engaged in creative work.

GOLD imports, amounting to \$782,000,000 since the beginning of 1915, have not the economic significance of normal times, but it is certain that the accumulation will do much to fortify the Federal Reserve Bank and place the country on a sound basis, as against the period of disarrangement inevitable at the close of the War.

AMORTIZATION of the capital used in mining is a subject of direct practical interest, especially in these days when the amount of capital so used runs into huge sums of money. We publish an incisive article by Mr. Robert S. Lewis, Associate Professor of Mining in the University of Utah. We shall be glad to see the subject discussed in our columns.

TWO nominations have been made for the presidency of the American Institute of Mining Engineers: Mr. Sidney J. Jennings of New York and Mr. Philip N. Moore of St. Louis. Both are so well worthy of the honor that it seems a pity not to arrange for one of these gentlemen succeeding the other. Unless this is done the voting may be prompted by sectional sentiment, the Western men rallying to Mr. Moore while the Eastern cast their ballots for Mr. Jennings. Something should be done to prevent needless competition.

SENOR Luis Cabrera and his two associates on the International Commission are discussing Mexican affairs with Mr. Franklin K. Lane and the other two American commissioners, but the Mexican delegates are not wasting the time between these debates; they are making the most of a favorable opportunity to raise money, in the form of a loan. It is not clear to us how any banker is justified in lending money to the Mexican government under Mr. Wilson's doctrine that the United States is not called upon to protect the financial interests of its nationals abroad, particularly in Mexico. The money invested by Americans in the mines and other industries of Mexico went there on a guarantee of protection and fair treatment from the Mexican government, and on the understanding that the American government would insist on such protection and just treatment. But the administration at Washington has washed its hands of the bold bad men that go to Mexico

to engage in legitimate speculation and honorable industry, so how can any banker feel safe in loaning money?

FLOTATION royalties were discussed in our last issue. In the July statement of development, production, and costs at the Goldfield Consolidated we note the following: flotation royalty, 5 cents per ton of total ore, and filter royalty 3 cents. Previously this company was paying 5 cents per ton as filter royalty. The introduction of flotation evidently has reduced the quantity of pulp filtered. As mentioned on page 438 of the September 16 issue, flotation at the Goldfield Consolidated has been suspended for two or three months pending installation of additional apparatus, cyanidation being resumed meanwhile. Treatment charges, excluding royalty, amount to \$2.11 per ton.

ON another page we give an abstract of a useful paper prepared by Mr. Hennen Jennings, assisted by Mr. Charles Janin, on dredging in Montana. The information deals principally with the Conrey Placer Mining Company, which operates four large dredges at Ruby. In our issue of December 25, 1915, Mr. Jennings gave us a few notes on results obtained, but this is the first time that such detailed data have been made public. Alder Gulch and Ruby were the birthplace of many important improvements in dredges, such as are typified in the big machine now at work there. Mr. Jennings concludes his paper as follows: "Outside the practical economic considerations involved, it appears that the development and working of a great gold-dredge has a very far-reaching and ethical meaning. The No. 4 Conrey dredge may be taken as an example. This was the product of no one locality, the child of no one brain, but rather the result of persistent and progressive effort in all dredging-fields and machine-shops, extending over nearly 20 years, and behind these efforts were the scientific and inventive discoveries of the age. Its record month's work of 400,000 yards, or 600,000 tons, to a depth of 54 feet, must be considered in connection with the statement that the total number of men at work on this dredge was only 10 in all. Yet, with the mighty steel and electrical tools at their command and the force chained to service from water-falls 26 miles distant, these men on the firing-line and supported by the machine-shop reserves could each be accredited with having raised 2000 tons of gravel, some of it from a depth of 54 feet below water to 40 feet above; then sorting the gold-bearing gravel from the barren, spreading it out on gold-saving tables, extracting the gold, and then elevating and

stacking the waste in such a way that future operations were in no way impeded, and all for an operating cost of about three cents per ton, and this in eight hours. How many men with mere muscular energy at their command and primitive appliances would it have taken to do this work? To the writer it would appear that the miner, mechanic, metallurgist, chemist, engineer, and scientist have increased the laborer's power in this instance a thousand-fold and created for him work necessarily abandoned under old conditions." These are just observations, and they are stated by no mere novice, but by a man of world-wide experience. Yes, the art of mining, also that of metallurgy, depends upon the co-operative effort of the many workers rather than the single effort of the individual genius. It is the aim of a professional paper such as this to co-ordinate the work of the many and bring them in mental touch.

A Walled Mexico

Carranza is trying to build a wall of exclusion around Mexico. With every new decree the hopelessness of re-establishing normal relations with the devastated republic grows deeper. Capital and an army of peaceful workers have been eagerly waiting to resume the task of reconstruction, but the protection of our own Government is withheld, while new barriers are daily erected by Mexico. Carranza has found encouragement in his follies from the incomprehensible attitude of President Wilson. When the chief magistrate of the United States utters platitudes befitting a high-school debater, affirming that he believes in the right of the Mexicans to do as they please with their own country, and that Mexico is justified in concluding, from the way in which some of our fellow-citizens have tried to exploit her privileges, that we wish to possess her, and adds that he will not serve the ambitions of these gentlemen, but will "try to serve all America by trying to serve Mexico herself," Carranza has warrant for thinking that the rights of our people may be ignored with impunity.

It was a quibble to assert that a country may do as it likes. Japan was able to live according to its own lights while its ports continued closed against the world, but President Wilson might have reflected that no other than the United States of America took the initiative in denying Japan's right to voluntary exclusion as a hermit kingdom. When Commodore Perry in 1853 forced open Japan's doors, the United States gave peculiar emphasis to the necessity for commercial intercourse as a fundamental principle henceforth to be recognized within the family of nations. Intercourse is regulated by formal conventions, and as soon as a nation enters into a treaty of amity and commerce it has limited its self-centred independence by a new set of mutual rights and obligations.

It is the duty of our Chief Executive to sustain the rights thus acquired in Mexico. No decree of a *de facto* government can impair them legally. Our treaties give us the most-favored nation privileges, which place our

nationals, in nearly all respects except political status, on an even footing with the citizens of Mexico, subject to the municipal law of the land. Only a constitutional government can alter these, and Mexico is today without such a government. In recognizing Carranza, the President merely became a party to the carrying out of treaty engagements subject to previous constitutional enactments, as *ad interim* administrator of the affairs of Mexico. Nevertheless, the innocent investor is abandoned because a few have wrongfully used their influence and financial strength, so the future investor, though reading in the solemn treaties ratified by his country's Senate what rights he possesses in Mexico, finds that the penalty for daring to go abroad and invest his labor and his money is expatriation.

In time, if Mexico finally should settle down to orderly government, it is to be presumed that rational treatment of foreigners will be accorded by statutes in conformity with her treaties; but the outlook for internal peace becomes daily less promising. The future is still more darkly over-shadowed by one of Carranza's latest decrees. Behind the revolutionary bombast of ambitious leaders, and underneath the ravaging fury of loot-maddened mobs, lies a reasonable and comprehensible revolutionary purpose. This is the profound intent of the defrauded poor to regain their lands. The pitiful story of systematic robbery by legalized injustice, whereby the lower classes were stripped of their inheritance and made little better than serfs on the land that had once been theirs, may be read elsewhere. The indictment against the land-grabbers, and the demand for restitution, can be found clearly and succinctly stated in just one Mexican document, and that is the *Plan de Ayala* formulated by the bandit Zapata. Every other leader of prominence has declared for the same reform, and by doing so has been able to gather supporters to his standard, but these are like the factitious planks in the platforms of our political parties compared with the ingenuous presentment and demand appearing in the proclamation of Zapata. Here is found the spirit of the Mexican revolution, the revelation of public wrong and the vision of justice that the spurious reformers have proclaimed only in feeble and halting phrase. It matters little what we may think of a demand for nearly universal confiscation of real property and its redistribution among the poor. The practical difficulties in the way of such a proceeding, the inevitable hardship and unfairness that would be wrought in the name of justice, the impossibility of carrying out equitably so radical a reform, these are matters for the Mexicans, not for us. The thing that we should recognize, however, is that agrarian reform is the popular motive of the Mexican revolutions, and that revolutions will not cease until the grinding injustice of the brutal old landlordism has been atoned in some quite effectual manner and rendered impossible of recurrence. Such semblance of peace and of constitutional government in Mexico as may come while this question remains unsettled will be evanescent. Stability of government is not to be antici-

pated until a genuine agrarian reform has been placed on a workable basis.

Carranza is, of course, the owner of great estates. He acquired them in the conventional manner of the old land-thieves. The people have never ceased to whisper that he espoused the cause of the revolution in order to avoid confiscation of this property. Now comes announcement of a plan that strongly confirms the suspicion. The moral ground is artfully shifted. The guilt for which confiscation shall apply is crime against the government of Mexico. The manner in which land-titles were obtained does not enter into the question. Degrees of culpability are recognized, with graded punishment. Those who took up the great cause of liberation and reform have naturally washed out considerable original sin. Carranza is proposing to do by this decree precisely what Zapata long ago prophesied that he would.

To count on Mexico as a field for enterprise until the real problem of the masses is faced and dealt with practically by some capable leader is to ignore the verities of the situation. Carranza is a crafty demagogue of the old *científico* class. Zapata an illiterate peón possessed of an idea too big for his mastery, Villa too easy a prey to vanity when flushed with successes to measure up to the dignity of great responsibility. The day of regeneration for Mexico has not yet dawned, despite the clamor of some false prophets; neither is the day near when Americans may return to develop the mineral and agricultural resources of Mexico with assurance that their rights will be sustained in keeping with the truth plighted between Uncle Sam and Guadalupe in their now long-forgotten treaties.

Elmore and Flotation

On another page we publish an intensely human document, nothing less than a personal statement by Mr. A. Stanley Elmore, in behalf of himself and his brother, Francis Edward Elmore, covering their invention of the original bulk-oil flotation process and the later developments of this metallurgical method, with special reference to the unpleasantness between them and the gentlemen now identified with the Minerals Separation company. We had written to Mr. Elmore asking him for sundry items in the chronology of the early flotation work, but instead of a dry record he sent an appeal addressed, through our columns, to the profession at large, more particularly those, and they are many, interested in the quarrel between the two groups of men so long engaged in a contest over the rights to the basic patents and the profit that flows from them.

Those that have read the recent book, 'The Flotation Process,' will be able to follow Mr. Elmore's statement intelligently, even sympathetically, for the editor and compiler of that volume is numbered among the many that think the Elmore brothers were given the short end of the stick in the pull between the opposing interests. Much of what Mr. Elmore says is already known in

London, where the flotation vendetta is better understood than the technology of the process, but it will convey a good deal of fresh information to our readers on this side of the Atlantic. We have refrained from editing the statement, preferring to give it exactly as it came to us; otherwise we might have deleted the Herodotus story, which is apocryphal. The emphasis on the dryness of the ore treated by Haynes and Everson is to the point. As our readers are aware, we take no stock in the Everson myth, which was over-worked by the opponents of Minerals Separation, no less than by those of the Elmore brothers. The argument that George Robson avoided "the use of an excess of water" is new, but it is not unreasonable, because he depended upon the direct agency of an excess of oil, as much as three tons of oil to one of ore. Mr. Stanley Elmore recites the way in which his brother first became interested in the subject, but he does not explain that the plant in which his first experiments were made was the one, at the Glasdir mine, in which Robson had made his ineffective attempt. We ask him to clear this part of the history; for we have been informed on good authority that Mr. Frank Elmore found the remains of Robson's experimentation, in the form of oil, pulp, and apparatus, at the Glasdir mine when he himself first arrived there. In the statement by his brother we are told that an observation of the effect of lubricating oil, dropping on a launder, in concentrating particles of chalcopyrite, suggested the use of oil as a flotation agent. Possibly this, and the other observations mentioned, led to experiments with Robson's apparatus. If there was no connection between Robson's abortive effort and Elmore's valuable invention, it should be made known. Mr. Stanley Elmore does not give the name of the mine. The fact of such a connection between Elmore and Robson would be interesting and it would not detract from Elmore's credit as an inventor, for Robson failed in devising a workable method, while Elmore succeeded, thanks mainly to his unquestioned skill as an engineer.

Next we come to the beginnings of the Elmore syndicate. It is obvious that the start was auspicious, in that it was made with the financial backing of Wernher, Beit & Co. and with the benefit of the engineering experience of such men as Messrs. Walter McDermott and Hennen Jennings. Mr. Frank Elmore had recognized the use of a thin pulp, that is, the presence of plenty of water, so that the oil might have "a free choice between the wet mineral particles and the wet rocky particles"; but, in his first invention he missed the third essential, one as important as the water and possibly more important than the oil—namely, air. Reference is made to Mr. C. M. Rolker's paper on the Elmore bulk-oil process as conducted at the Glasdir mine, a paper read before the Institution of Mining and Metallurgy in London on April 25, 1900. To those familiar with the recent development of the flotation process it is intensely interesting to note that at that meeting several references were made to the fact that while the difference of specific gravity between the oil and the water gave a floatative margin of 10%, yet

the oil was loaded to as much as 28%, and even then "the oil had an ample amount of buoyancy to allow of it readily floating on the surface of the water." I quote Mr. McDermott. On that occasion Mr. Frank Elmore quoted the manager, the late John Bevan, as saying that the flotative efficiency of the oil was 25% against the theoretical load of 10%, and he, Mr. Elmore, remarked that "it seemed rather strange that there should be such a difference between theory and practice." Of course, we see now that all of them failed, at that time, to detect the part played by the air, which was entrained with the ore and water while they were being mixed in a revolving drum. Mr. Rolker said: "The viscosity of the oil is the all-important point." Mr. McDermott said that "there was no doubt that the success or failure of the process depended largely on the amount of oil lost in the operation." Nobody, neither Mr. H. L. Sulman nor Mr. H. F. K. Picard, who also took part in the discussion, made the slightest reference to the agency of the air in promoting the flotation of the chalcopyrite. As far as we know, the first public recognition of this basic fact was a statement by Mr. McDermott, in the *Engineering & Mining Journal* of February 14, 1903, when the present writer was editor of that journal, acknowledging that "the agitation with the pulp results in the oil taking up a very appreciable quantity of air." It remains to add that on January 3, 1903, Mr. Stanley Elmore took out a patent to *exclude* air from the apparatus, by means of a ring or surface of oil, the idea being to prevent the oxidation of the minerals, but the result was to banish a prime agent in the separation between the sulphide particles and the gangue. We hasten to say that the Elmore brothers were the first to take practical cognizance of this error, for their vacuum-oil patents of 1904 are based on the use of air naturally dissolved in water, and from these patents the growing recognition of the part played by air was emphasized progressively until today the process is essentially one performed by a maximum of bubbles generated in the presence of a minimum of oil as against the original Elmore operation in which a maximum of oil was aided surreptitiously by a minimum of air. Returning to Mr. Stanley Elmore's statement, we agree with him that the establishment of a demonstration plant in London, in 1901, and the access thereto granted to metallurgists, together with the lavish publication of information concerning the process, did do a great deal to stimulate interest and curiosity, contributing thus to the later developments whereby the process was turned inside-out and made of inestimable value to the mining industry. For instance, these publications served to attract the attention of Aleide Froment, in Italy, and caused him to make experiments destined to play a decisive part in the development of flotation. What Mr. Elmore says about the experiments in agitation, including the use of the Gabbett mixer and centrifugal pump, as early as 1902, is interesting, for this led, we presume, to the recognition of the assistance given by air and thus to the vacuum patent of 1904. It is claimed that from that date "minute pro-

portions of oil with violent agitation were in constant use, producing a 'froth' in industrial plants on a large scale." We do not doubt that 'froth' was formed under such conditions. What is a "minute proportion" of oil? Of course, to anybody that has used a ton or more of oil per ton of ore, anything like 10 pounds per ton seems minute; and in later plants the oil employed with the vacuum process has been reduced to less than 3 pounds per ton of ore.

This brings us to the episode that did so much to embitter the relations between the flotation groups in London. Mr. Elmore tells the story of the option granted to Messrs. Hay, Webster, and Ballot in 1901 and the access given thereby to the Elmore plant and operations, whereby Messrs. Sulman and Picard were enabled, in 1902, to become familiar with every detail of the process as then conducted. To what extent, if any, Messrs. Sulman, Picard, and Ballot took advantage of this opportunity to learn the Elmore methods and how much they were aided thereby in devising the method patented by them in 1905, it is not for us to say, seeing that the matter was ventilated in a court of law, but it is obvious that Mr. Elmore expresses a keen sense of betrayal. We know that both of the Elmore brothers resigned from the Institution of Mining & Metallurgy when Mr. Sulman was nominated to the presidency of that professional society in 1911, but this incident indicates the bitterness rather than the merits of the quarrel; it is a fact, however, that the option episode has been at the bottom of the acerbity shown in the litigation ever since. The decision of the German patent-office, in 1909, is recorded in the books on flotation, but some of our readers may have overlooked it. But the more important note is that concerning the first litigation over the Froment patent, purchased in 1902 by Minerals Separation, the company organized in 1903 by Messrs. Hay, Webster, Ballot, Sulman, and Picard to buy the Cattermole coagulation patents. In 1914 the Elmore people, on final appeal, lost their suit for infringement against Minerals Separation, but this suit referred solely to the old bulk-oil process and ignored the improved vacuum or air method. Therefore the decision was of no moment to the American users of the process. The main contest over the patents is now in progress in the United States, as our readers are aware, by means of the suits brought by Minerals Separation against James M. Hyde and the Miami Copper Company, respectively. Here we leave Mr. Elmore's appeal. It will be read with keen interest, and we hope it may be followed by the information for which we have asked on one or two obscure points. Meanwhile, the profession at large will, we believe, join with us in recognizing the great service done to the industry by the Elmore brothers in their early development of the flotation process and in their later invention of the vacuum method whereby the agency of air became recognized, increasing the efficiency of a process that has revolutionized low-grade base-metal mining and bids fair to play an increasingly useful part in the concentration of the precious metals.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

MacDougall

The Editor:

Sir—Referring to your note in the issue of September 9, in regard to the proper spelling of the name 'MacDougall': The earliest reference that I find in our library is in the second edition (1891) of Vol. 1 of Lunge's 'Sulphuric Acid and Alkali,' where it is spelled MacDougall. Reference is therein made to British patent No. 3985, dated 1883, in which the inventor's name would, of course, be found as he himself spelled it.

CHARLES D. DEMOND.

Anaconda, September 11.

Machinery in Mining

The Editor:

Sir—The changed conditions affecting the cost of mining in California as compared with practice in 1869, given in your article on 'Re-opening of Old Mines Along the Mother Lode,' in the issue of August 12, should be of interest to those living in other mining regions. I was surprised to know that nitro-glycerine explosive was used in Californian gold mining as early as 1869. Its first use in America was, I believe, in 1867* at the Hoosac tunnel in the Berkshire hills of Massachusetts. Hand-drilling and blasting with gun-powder had been responsible for the comparatively slow work done in tunneling and mining. I had an idea that the low cost of mining today compared with the cost in 1869 was due principally to two influences: first to the introduction of improved machinery and high explosives, and secondly to the consequent speeding-up of the workmen as the unconscious result of handling fast-operating machinery in an age and country famous for their 'hustle.'

The point of view of the workmen is important. H. Foster Bain, in commenting on underground conditions in the gold mines of the Rand, speaks of the stopping of all rock-drills in a stope when a visitor enters, a customary matter of courtesy.† He adds "there is not the drive to the work to which an American is accustomed." In very few large American mines today are the rock-drills stopped when a visitor enters a stope. The spirit of the times here is opposed to such waste. I presume that in 1869 looser ways prevailed. I know that old Lake Superior miners relate how, 20 or 30 years ago, they customarily smoked and talked an hour underground before proceeding to work. In one large Michigan mine for

years the miners slept on night-shift after the midnight 'lunch.' Today the "drive of the work" in American mines to which Mr. Bain refers, is a decided change over the easy-going methods of the '60 and '70s. This should accrue to the advantage of a company re-opening a mine such as the Old Eureka.

Scarcely anyone will deny the tremendous speeding of underground work by the modern fast rock-drill, the steam or electric pump, and the improved high explosives. J. N. Wright, a former superintendent at the Calumet & Hecla mines, writing in 1895, said: "I have alluded to the great cheapening of the cost of production that has enabled the Michigan copper companies to maintain a profit in spite of reduction in the price of metal. The two agencies that operated to bring about this result were power-drills and high explosives. The great expense of a Michigan copper mine is the actual breaking of the rock, this being about double all other costs. For years engineers had endeavored to perfect a machine-drill. About 1870, the Burleigh rock-drill was tried at several of the copper mines, but, owing to its great weight and size, could be used in but few places, and the saving effected over hand-drilling was small. A few years later, drills of much lighter weight and of stronger construction were perfected and were soon introduced into all the mines. In 1879, the Calumet & Hecla company, after a careful trial of the new drills, decided to introduce them throughout the mine as rapidly as they could be obtained, and an air-compressing plant was erected to supply motive power. High explosives (the nitro-glycerine powders) were also introduced at the same time. Previous to this all drilling had been done by hand, and only black powder used in blasting." From the above it is evident that the Michigan copper mines, largely owned in Massachusetts where the experiments with rock-drills and nitro-glycerine were initiated, tried the Burleigh rock-drill in 1870 and found it unsuccessful. Nitro-glycerine explosive seems to have been adopted at the Michigan mines in 1879. Mr. Wright continues: "The result was that in sinking, drifting, and stoping, the price per foot and per fathom, respectively, was reduced one-half, and a saving of at least \$200,000 effected. A few years later this saving over hand-labor amounted to \$500,000 per annum, and at present (1895) with largely increased production, I am confident that \$2,000,000 would not misrepresent the annual saving by underground machinery at the Calumet & Hecla mine alone. This is the direct saving, but it only partly expresses the net result, for the indirect advantage is great. Not only were prices reduced one-

*M. & S. P., Oct. 10, 1914.

†M. & S. P., Aug. 26, 1916.

half, but as the same force of men were enabled to do double duty, the company was soon able to double the amount of output upon which its profit was based. Trouble from smoke and foul air was also greatly diminished. We have heard much in recent years of wages reduced and men thrown out of employment by the introduction of labor-saving machinery. But such has not been the case in the Copper Country. To operate the machinery, which had replaced the old hammer-and-hand drill, greater skill was needed. Brighter men found employment, and the wits of the older and duller men were sharpened. Their ambition was stimulated, and they were able to do, and did do, better work than before. Their wages were increased instead of diminished, and the company, profiting by the increased output, not only retained all their men, but gradually added to their number."

It would seem that Mr. Wright, writing 20 years ago, described an industrial revolution much the same as took place in the Copper Country during the last five years when the one-man drill and 'efficiency' ideas were introduced. James MacNaughton stated recently that "the use of the one-man drill and Carr bit at the Calumet & Hecla mines has resulted in an increased output per miner equivalent to his total production of a few years ago."

That labor-saving machines economize work is unquestioned, but that a further advantage ensues from providing more work is not so well understood. Putting a mechanical drill-sharpener in a mine's blacksmith-shop immediately effects reduction in the cost of sharpening the drills. But, as pointed out by the *Compressed Air Magazine*, the consequent ease and quickness with which drills can be sharpened leads to more frequent sharpening of them; that is, when a bit becomes worn, the miner does not waste time trying to work with a dull tool, but changes to a sharp bit; he knows that dull bits can be sharpened easily and cheaply. This procedure is typical. The speeding of one link in a chain of connected operations is likely to spur others, and one improvement leads to another. The principle that the saving of work makes more work sounds paradoxical, but is quite as true as the axiom that "money makes money, and the money that money makes makes more money."

Referring again to your article 'Re-opening of Old Mines Along the Mother Lode,' surprise might be expressed that miners' wages in California today are nearly the same as in 1869. We are accustomed to think that the wages of all workmen in the United States have risen steadily since a generation ago, partly on account of the increased cost of living. This is exactly the reason why wages on the Mother Lode have not increased, because the cost of living there is lower than in 1869. In those early days the high freight-rates and the lack of agriculture in California made for high prices in most of the necessities of life. Today a miner in California can, and does, support a family in comparative plenty on the wages that in 1869 only sufficed to keep a single man in good health and spirits according to the generous stand-

ards of those bluff times. The cost of living in California has increased recently by reason of the widening demand for luxuries, but a miner on the Mother Lode lives most comfortably in the snug mining towns, reinforcing his wage by the produce from his garden and by the modern facilities for economizing in the home.

Berkeley, August 15.

P. B. McDONALD.

Lime From Molluscs

The interruption of the usual supply of lime, at a Mexican mill recently, made it necessary to find a local supply until importations could be resumed. Fortunately the mine was not far from the sea-beach, where there were large mounds of oyster and clam shells. The natives for a long time had produced lime by burning the shells in heaps. Small-scale tests indicated that lime could be produced economically in this way. It was found that the clam-shell was higher in lime content and more easily burnt than that of the oyster.

A small vertical brick furnace was first tried but discarded. The flames would not pass through a column of shells more than a foot or two in height. When heated the shells began to disintegrate, closing the air-passages and damping the fire. As fire-wood was cheap and plentiful, burning in heaps was tried. A few logs or pieces of old timber were first laid down, about a foot apart, covering a space 10 by 20 ft. On these was spread a layer of fire-wood making a floor for the shells, which were piled to the thickness of six or eight inches. Another layer of fire-wood was followed by a layer of shells until the heap was about four feet high. A few logs were placed upright in order to leave vents in the mass after they had burned. About three cords of fire-wood was needed to burn ten tons of shell. The wood was ignited from the centre of the heap, where oiled waste had previously been placed. In 24 hours the wood was consumed, leaving a hot glowing mass, which was allowed a day to cool.

The fire-wood was dry and burned to a white ash, leaving little charcoal, which would have been objectionable in the cyanide solutions. Lime yielding 39% CaO was obtained using this method. Two pounds of the shell-lime was approximately equal in strength to one pound of good rock lime. There was a loss in weight in burning of about 25%, so that 10 tons of shells produced about 7½ tons of lime. Some of this lime was used for mortar and found satisfactory.

The zinc-lead deposits of Brecken Hill, Rhodesia, are the only important ones known in South Africa. The metals occur as carbonates, and owing to their intimate mixture, coupled with the long distance from market, the deposits so far are unprofitable.

IRON-ORE SHIPMENTS from the Lake Superior districts up to September 1 totaled 39,215,864 tons. This is over 7,000,000 tons in excess of the same period of 1913, a record year.

The Invention, Development, and Introduction of the Flotation Process

By A. Stanley Elmore

For some considerable time past I have been urged by friends to prepare for publication some notes on the history of the flotation process; several reasons have conspired causing me to hesitate. First I very much dislike anything which might look like "blowing my own trumpet;" second, I believed that the facts were pretty generally known to that considerable circle of personal friends I am glad to have among engineers and metallurgists who have studied this matter and who know to whom the credit for the first invention of the flotation process is due.

Notwithstanding the sympathetic dedication to my brother and myself of Mr. T. A. Rickard's interesting book 'The Flotation Process,' I feel the necessity of such an authoritative statement as I am asked to make, if the real history of this matter is not to become buried under a mass of prejudiced statements and legal subtleties advanced by various people whose only desire is the present support of a particular position in an involved law-suit.

Moreover, there appears to be so much misconception among others in connection with a few simple matters that I will endeavor as briefly as possible to set down the actual facts.

It would seem that the varied assortment of travelers which have passed along the highway of flotation do not appear to have been animated by the same intentions and desires. Some have trodden the road carefully, noting and correctly interpreting the inscriptions on the sign-posts. Others have read and failed to understand these inscriptions, while others again have accepted money-payment for attempts to obliterate and alter the original wording, in the hope of confounding the non-technical legal gentlemen who were expected to traverse the road after them.

The first sign-post on the road was erected by Herodotus about the year 450 B.C. Although the inscription is so old it is quite distinct and tells of a band of virgins, who, by daubing feathers with pitch and subsequently drawing them through the mud of a certain lake on an island called Cyranis where they were in the habit of bathing, recovered gold-dust in this way.

There is no record of these chaste maidens having been greatly enriched by the working of this simple metallurgical process, but notwithstanding this lack of evidence of 'utility' a certain learned counsel had the temerity to suggest that this "prior publication" invalidated the Elmore patents, which were filed several thousands of years later!

After a tramp of some two thousand years or more

we arrive at the sign-post erected by Haynes in the year 1860. This gentleman wrote a clear unambiguous inscription telling the reader to grind *dry ore* with an "agent" consisting of guttapercha, resin, India rubber, tar, oleaginous matter, in a 'pug' (or mortar) mill; the other things he told one to do need not be quoted because they are not so clear, and it is sufficient for the development of my argument that the beginning of the process he suggests was to grind *dry ore* with a mixture of guttapercha, etc., etc.

It would be an insult to the intelligence of a present-day metallurgist of independent judgment to discuss this sign-post as an anticipation of the flotation process, so we may pass on to the Carrie Everson inscription, dated 1885, which again instructs the reader to incorporate his dry ore with mixtures of oils, etc., etc., till such time as the mass becomes of a putty-like consistence.

Not a practical detail of how to carry out the operation is given; it is in substance the same as Haynes, and they are both of about the same practical utility as the efforts of the virgins to obtain the grains of gold from the mud of the lake—who knows, perhaps this gold defiled by contact with pitch was the "filthy lucre" of the scriptures!

It is a comparatively short step from Carrie Everson to Robson & Crowder, who put up their sign-post in 1894. They described a process for mixing with ground ore containing from 25 to 30% of moisture certain mixtures of fats, etc., and subsequently from the mass so formed elutriating the fine particles of mineral by means of a stream of kerosene-oil forced through it by a pump. Their directions for carrying out the process include specific instructions to avoid the use of an excess of water.

I have summarized these various suggestions—they were nothing more—in a few words because the original documents are all available and the great majority of engineers have doubtless read them. I have emphasized what to my mind is the cardinal point in connection with them, namely, they all were designed to operate by mixing the oil with dry or practically dry ore.

The successive suggestions so far mentioned added nothing whatever to the stock of public knowledge.

It has been said that the modern flotation process is the result of a gradual building up of experience and information, but I cannot accept that statement as applying to the period I am now dealing with. It is perfectly clear to me that neither Robson, Everson, or Haynes had the least idea of the cause of their own failure or of that of their predecessors.

Not one of these people ever described a process workable on a practical scale, neither did any one of them describe a practical form of apparatus for performing the proposed operation.

Notwithstanding the ransacking of ancient records, the raking over of the dust-heap of past failures, not one particle of reliable evidence has ever been produced that any of these suggestions did or could arrive at the stage of practical operation on a commercial scale. Nor has even the boldest of the attackers had the courage to try and demonstrate the working of any of these ideas in a large plant—for the very sufficient reason that they know it is impossible. Not one of these hopelessly impracticable schemes has ever emerged from the oblivion into which they fell and which they are so well calculated to adorn.

Failure is inherent in them, as every engineer knows, and it remained for Frank Elmore to discover the solution of the difficulty.

My appeal for an unbiased reading of the description of the suggestions set out above is addressed to engineers and metallurgists whose judgment will not be warped by their commercial interests and associations. I do not hope to obtain a fair hearing from those dishonest 'experts' whose veracity and conscience are elastic in proportion to the importance of the fee they get. Neither do I expect any admissions of value to this discussion from witnesses who will swear to particular facts in one Court and with equal solemnity swear to the exact opposite in another Court, justifying themselves on the ground of "change of opinion in the interval."

This little digression brings us along the highway to the sign set up by Frank Elmore in 1898.

Perhaps a few words which I think have not previously been published may be set down here as of interest as showing why and how Frank Elmore came to invent the flotation process.

At the time I speak of he was an engineer of known reputation having had a first-class scientific training in mechanical, electrical, and metallurgical engineering and wide experience of works construction and management, and was then in control of large metallurgical works in this country producing copper tubes and sheets by means of the Elmore electro-depositing process. He was recognized as possessing that rare combination of an imaginative or inventive mind coupled with sound practical ability to design plant for applying on a commercial scale the product of his imagination.

At this time William Elmore (his father) made a considerable investment with friends in a low-grade auriferous copper mine in this country. In due time an important plant consisting of the usual jigs, shaking-tables, etc., was erected and proved after the expenditure of much time and money to yield so low an extraction as to result in financial loss.

My brother and I were asked to investigate and see if the extraction could be improved. On the occasion of one of our visits to this mill it was observed that at the angle where one of the launders carrying the waterborne pulp deflected the stream, some splashing took

place, and it so happened also that oil had dripped onto the outside of the launder at this point from a shaft-bearing immediately overhead; a strong sun was shining upon it and a glittering reflection attracted the eye. On examination it was noted with interest that adhering to the oil was a coating of what appeared to be quite clean copper-pyrite and it was remarked that no rock seemed to adhere to the oily surface. A little later a piece of ordinary 2-inch iron steam-pipe, which was in such a position that the discharge from one of the slime-launderers splashed against it, was found by us to have a clear picture of a man's hand printed on it in bright copper-pyrite. It had been carried in a greasy hand and the whole of that part of the surface which had received a very thin coating of grease by contact with the hand subsequently became coated with pyrite.

It was these two accidental observations which led to the invention of the flotation process. These were the source of Frank Elmore's inspiration—at that time he had no knowledge of the virgins of Herodotus, nor of Haynes, Everson, or Robson & Crowder.

The fact was before us that finely-divided wet copper-pyrite would adhere to a greasy surface, whereas finely-divided wet rock would not. A means of separation was here indicated, experiments were immediately undertaken—on a small scale at first—gradually increasing in importance as encouragement was obtained.

The result of this work was the filing of Frank Elmore's patent of 1898. The process there described was applied on a practical scale at the mine referred to—one full-size working unit was first installed and others later.

Trials were being carried out on other ores and it gradually became known that we were working on a new method of concentration.

Up to this stage of development (a practical working equipment operated day and night by ordinary mill-labor) the whole of the funds—a large sum—had been provided out of our own pockets, as we were not desirous of inviting outside financial aid on something so startlingly new until we were convinced by practical results that we were justified in doing so. However, we were asked by my old friends Walter McDermott and Hennen Jennings, who had heard a little of what we had in hand, to let them see the process in operation. As a result of their personal inspection of the working-plant we were invited to allow them to make a thorough investigation by C. M. Rolker both of the mine and the process, and subject to his favorable report to join us in future development. In the end the mine was turned down at the price asked but McDermott, Jennings, and Werner Beit & Co. became financially interested in the process.

This then is a short account of the legitimate birth of what has turned out to be an epoch-making invention which has conferred a benefit of millions of pounds on the mining and metallurgical industries all over the world.

The inventors having thus associated themselves with men of high repute both from the technical, financial, and commercial side, naturally enough congratulated

themselves and were modest enough to believe that stability would be added to the business, progress be more rapid, and any tendency to 'swelled head' or demands for excessive royalties by enthusiastic inventors be kept better in check than it would if they had gone on entirely by themselves.

Now let us see how this invention so well conceived, so excellently supported, and with such bright prospects, remunerated the inventors and capitalists for the investment of their energies, enterprise, and money.

First let us understand what Frank Elmore had in fact invented, let us see in what main outstanding way what he did differed from those who are now said by a certain class of 'experts' to have anticipated him.

He accomplished by what, it is no exaggeration to say, was a stroke of genius:

(a) A continuous-working process.

(b) The treatment of the ordinary product of the almost universally employed wet-crushing plants.

(c) A practical form of apparatus mechanically perfect and capable of successful operation by ordinary unskilled labor.

Not one of these things had been accomplished by any of his predecessors who had made suggestions for the treatment of ores with oil.

It is easy to see why Frank Elmore was able to achieve so much in so short a space of time—to materialize all that is conveyed in the three simple statements (a), (b), and (c) above—to command commercial success where only failure, complete and unequivocal, had preceded his work.

It is quite obvious to those who bring an unprejudiced mind to the investigation that Frank Elmore was the first to appreciate the real fundamentals required as a basis upon which to build.

It fell to his lot to make the great discovery—simple in itself—that the essential element of success was the introduction of the oil to the ore in the presence of a large quantity of water; in other words, to give to the oil a free choice as between the wet mineral particles and the wet rocky particles. This fact, of cardinal importance, had never been recognized, appreciated, or understood before—had never been hinted at in any of the earlier adumbrations. In sober fact Frank Elmore did exactly the reverse of what had been attempted before—he did what he was warned not to do; he succeeded where those issuing the warning failed. Yet there are still to be found those who will for fees paid say that what he did was the same as what had been attempted by the earlier workers who had specifically rejected the very thing which gave Frank Elmore complete success.

The following few lines from one of the claims in Frank Elmore's first patent is ample justification for what I have said on this point:

He describes his process as "mixing the pulverized ore first with water in considerable quantity, then adding to the mixture an oil of the kind described, which adheres to the metallic constituents but not to the wet rocky constituents."

stance of the science, art, and practice of the flotation process as known today.

Here for the first time one is told in plain words the three essential elements for success (1) pulverized ore (2) a large quantity of water (3) the addition of oil of a kind which will adhere to the wet metallic particles but not to the wet rocky particles.

Everyone knows that prior to Frank Elmore's patent the oil was to be mixed or ground together with the dry or substantially dry ore. The oil was thus effectually forced into contact with both the metallic and the rocky particles—no free choice was given to the oil—no opportunity to select its natural partner was afforded—and failure resulted.

Everyone equally knows that subsequent to Frank Elmore's patent every flotation plant which has been erected depends for its success upon the use of a large quantity of water and an oil which will adhere to the metallic particles but not to the rocky particles. In every one of the plants without exception the oil is given a free choice in a perfectly mobile mixture of pulverized ore suspended in a large quantity of water. This complete invention cannot be better described than in the words of the claim of Frank Elmore's German patent quoted hereafter.

Having made this important far-reaching discovery, which may be described as "the selective action of oil in the presence of a large quantity of water," and which James Swinburne has described as "the work of a genius or a madman," it was not difficult for anyone with Frank Elmore's mechanical ability to design suitable apparatus in which to carry on the process as a continuous operation.

In a paper describing the Elmore process that C. M. Rolker read before the Institution of Mining and Metallurgy in April 1900, he said: "The mechanical contrivances brought into action by the inventor are excellently adapted to the work demanded, and bespeak very careful thought, as well as patient, systematic, and highly intelligent work. Seemingly insuperable mechanical difficulties in the initial stage have been very ingeniously overcome, and the process has arrived at a practical working stage."

Now while the industrial plant at the mine before-mentioned continued to work successfully and give increased confidence as to the future of the process as a result of the trials on bulk parcels of ore from other mines, Wernher, Beit & Co., Mr. McDermott, and the brothers Elmore formed a private syndicate in which they were the sole shareholders for the purpose of carrying on the development and introduction of the process. That syndicate hung out its sign early in the year 1901 at a demonstration works in London which was equipped with a complete crushing-mill and a full-size working unit of Elmore plant having a capacity of 25 to 30 tons of ore per day, to which was shortly added another unit, bringing up the capacity to, say, 50 to 60 tons per day. This works was maintained with a large staff and was open to all interested to see the process in practical operation. The visitors' book contains the

I say that in those words is to be found the whole sub-

names of most of the engineers and metallurgists of note resident in this country or visiting from abroad. It was situated in the east end of London and was so popular as a place of pilgrimage for professional men that it became known as the "metallurgical Mecca."

A conservative estimate compiled from the works records shows that during the period 1901-1915 some 4500 to 5000 samples of ore from different mines in various parts of the world were tested on a small scale and about 150 bulk parcels of ore varying from 5 to 100 tons each were treated under working conditions in a full-size commercial unit of Elmore plant.

It was in the year 1901 that the syndicate first issued literature describing the process and calling attention to its possibilities. About 50 different pamphlets in seven different languages were published and widely distributed—to the extent of about 125,000 copies. It is probably true to say that in practically every mining country in the world the technical press contained articles describing the process and indicating possible lines of application.

The process was investigated both at the demonstration works in London and in the working-plant at the mine on behalf of intending users by a number of well-known independent engineers. The result of this propaganda was that up to the year 1904 about 30 units of plant had been supplied to ten different mining companies. The aggregate capacity of these 30 units was, say, 300,000 tons of crude ore per annum. They were applied to ores containing copper, pyrite, gold with iron pyrite, copper-gold-silver, telluride of gold, and silver-lead ore.

I have elaborated this part of my narrative because the period I am now dealing with is the turning-point in the history of this now great industry. I am desirous of emphasizing that prior to Frank Elmore in 1898 nothing practical or commercial had been accomplished, that by his fortunate discovery of the selective action of oil in the presence of a large quantity of water success was immediately achieved. This is proved as shown above by the investigation of independent engineers and by the large commercial installations made. Moreover, it is accentuated in a remarkable way by the fact that every flotation plant in operation at the present time is characterized by the use of a large quantity of water with the crushed ore.

It will be noted that I have put this period of active development between the date of Frank Elmore's first patent and the year 1904. I have done this purposely because I wish to deal with his inventions of later date and their development separately; but for the purpose of keeping the record in order I wish to turn back on our high-road of flotation to the year 1901, when my own minor contribution was made in the form of the discovery that a slight acidulation of the mobile mixture of ore, water, and oil greatly enhanced in some cases the selective action of the oil. I wish to state here also that during the progress of the development of the Frank Elmore invention, most exhaustive trials were made with various kinds of oil and mixtures of oils, vegetal,

animal, and mineral, of all degrees of viscosity from solid or semi-solid waxes to the lighter spirits such as turpentine, benzol, etc., etc. Nor were the investigations confined to 'oils' alone; experiments were made with many substances which for the purposes of this process acted in a similar manner to oils.

The effect of various degrees of temperature was studied and much attention was given to the question of the degree of agitation as affecting the results obtainable on different kinds of ores. Many forms of mixers were designed and employed, giving degrees of agitation or mixing from the most violent turbulence down to a mere gentle stirring. It is worthy of note here that in the London testing works in the year 1902 a Gabbett mixer (a vortex-mixer giving a violent agitation with the incorporation of large quantities of air) was employed at the suggestion of Mr. McDermott in an elaborate series of tests carried out on telluride of gold ore from the Lake View mine in Western Australia. At the end of 1902 a working-plant was sent to that mine in which the ore, water, and oil passed through high-speed centrifugal pumps used with the object of securing the most violent agitation of the oil with the particles of mineral and rock freely suspended in the large quantity of water employed.

At these London testing works and in the various mine installations observation was constantly made of the various forms of 'float' which were obtained. It was noted for instance, that varying proportions of the mineral would be buoyed up or floated to the surface or maintained on the more or less quiescent surface of the water by (1) a large excess of oil, (2) a mixture of oil and air, (3) individual oil-coated particles floating by 'surface tension,' (4) a froth of oil-coated mineral particles and air, (5) individual oil-coated particles or aggregations of oil-coated particles attached to separate air-bells.

Sometimes all of these phenomena could be seen in different parts of the same apparatus. It was also remarked that with certain proportions of some kinds of oil some minerals would form aggregations which would sink. But it is to be remembered that all such phenomena were ancillary, subsequent to and dependent upon the differentiation of the mineral and rock particles resulting from the previous selective action of the oil employed.

Various proportions of oil were tried—the investigations were even carried so far as to prompt trials with ground cork, chopped straw, and similar buoyant materials which had been previously coated with oil or grease. It was found that by mixing such materials with a mobile mixture of ore and water quite a good extraction could be obtained in some cases—each little ship floating with its cargo of mineral, or being grouped together with air-bubbles making a froth.

It is probably true to say that up to 1904 all commercial working-plants had been operated with a large quantity of oil. That is, instead of buoying up the previously greased mineral particles by means of air-bubbles in the form of a froth, as he did in his later patents, Frank Elmore up to, say, 1904 preferred to employ an

excess of oil with which was incorporated a large quantity of air for this purpose.

In the interests of historical accuracy I cannot too strongly insist upon the basic fact that the flotation process consists essentially of two steps: first, the *differentiation* of the two sets of particles by causing one set to be wet with oil and the other set to be wet with water in the presence of a large quantity of water, so that the oil has the best possible opportunity of exercising its free choice; second, the subsequent *separation* of the differentiated particles.

It is perfectly obvious that the first step—the differentiation—is the all-important one because the second step, the separation, cannot be made commercially unless a practical way of securing the requisite differentiation has first been devised and applied.

It is with probably a better, fuller, and more intimate knowledge of all the facts and people connected with this business than anyone else possesses that I unhesitatingly claim for Frank Elmore the discovery and invention of this essential principle and process—the principle and process which has been incorporated into every flotation plant which has up to the present time been worked on a practical scale.

I wish it to be understood here that I am not saying that ingenuity, and even invention, may not have been and may not still be exercised in improving methods of *separation* of the differentiated particles, but I do say that whatever the method of separation employed, be it 'froth,' 'surface tension,' 'greased cork,' or what not, the pith and marrow of Frank Elmore's basic invention has first been employed to render that separation practicable.

Precisely the same argument applies to my 'acidulation' patent of 1901—it was a mere addition to or improvement upon Frank Elmore's basic invention of 1898, it was a way of enhancing the selective action of oil in a mobile mixture; of increasing the power of differentiation of the oil in the presence of a large quantity of water. Exactly the same thing may be said of my patent of 1901 for the use of a greased belt for collecting the greased mineral particles and separating them from the non-greased rock particles. Neither of these inventions could be put into practice except in conjunction with, or as an addition to, the fundamental process of selectively greasing the mineral particles.

At this point it may be useful to note that my 'greased belt' patent of 1901 is the first publication showing an apparatus in which small quantities of oil *must* be used—it is not capable of practical use with large quantities of oil; and while on this point I would like, in emphasizing the date, to quote a few words from Frank Elmore's patent—vacuum process—of 1904.

After referring to processes for separating ores by means of tar or oil, soap or the like, or with an alkali, an acid, air, or gas, he goes on to say: "By the present invention all such processes are improved, *more particularly in the respect that a smaller proportion of the added substance, such as oil or acid, may be used*, by conducting them wholly or in part under a reduced pressure.

For instance, a vacuum or partial vacuum may be maintained in the separating vessel or chamber."

I have dealt rather fully with these questions of degree of agitation, quantity of oil, and condition of float, and quoted dates and references because for some considerable time past, in absence of definite public statements to the contrary, increasing claims to priority have been and are being made without any proper justification. I would like to record in unequivocal terms that prior to the filing of Frank Elmore's vacuum patent of 1904, he and I, and those associated with us, were fully aware of the advantages and drawbacks connected with the use of a more or less violent agitation and of the effects of small and large proportions of oil.

I do not wish it to be supposed that I am claiming that my 'greased belt' patent of 1901 ever came into general use or that small proportions of oil were common at that date, but I do wish to be on record definitely and emphatically that from the date of Frank Elmore's vacuum patent (August 1904) minute proportions of oil with violent agitation were in constant use producing a 'froth' in industrial plants on a large scale.

It may be well to set down the fact that these vacuum plants have *never* been employed with a large proportion of oil. As is well known, in such plants the flotation of the greased mineral particles is secured by the attachment of bubbles of air or gas. In every one of the, say, 150 units of vacuum plant supplied (of an aggregate capacity of about 2,250,000 tons of ore per annum) the flotation of the concentrate results from the use of a violent agitation, a minute proportion of oil, and the production of a froth.

It will be understood that I make these statements in refutation of many claims made in connection with the patent dated April 12, 1905, applied for by Sulman, Picard, and Ballot—eight months after the date of application of Frank Elmore's vacuum patent.

As everything which followed the Frank Elmore patent of 1904 seems to me to be in the nature of ordinary development of working details, I do not at present purpose to follow the technical side of the matter further, believing that what I have already set out is sufficient to enable unbiased investigators to properly and fairly apportion the credit in this matter.

These notes—incomplete and abridged as they are—are already longer than I had intended, but as there are several points of interest that have been misunderstood in connection with the seemingly interminable litigation, I venture to draw still further on the patience of my reader.

Toward the end of the year 1901, Messrs. Hay, Webster, and Ballot entered into an agreement with the Ore Concentration Syndicate Limited (owners of the Elmore patents) under which those gentlemen in consideration of certain payments secured an option on the Elmore patents and all improvements for Australia. The option was for six months, with right to them, on making further payments, to a further six months. Messrs. Hay, Webster, and Ballot were to be entitled

during the option period to send parcels of ore for testing to the Ore Concentration Syndicate works and they and their workmen, experts, and agents, were to have free access to and liberty to remain on the Syndicate's works for supervising the tests. The Syndicate, when required, was to give to Hay, Webster, and Ballot all the information in its power respecting any tests made; and to furnish information as to the plant, the oil, and other things necessary for the treatment, and were to supply copies of reports made by its experts on its inventions in any part of the world, etc., etc.

One of the considerations to the Ore Concentration Syndicate under this agreement was contained in Clause 7, of which the following is an extract: "From and after date hereof" Messrs. Hay, Webster, and Ballot "and their assigns * * * shall from time to time, after making or becoming entitled to any improvement in or addition to the said invention or process or any discovery useful for separating metallic from the rocky constituents of ores by the use of oil forthwith give notice thereof in writing to" the Elmore Syndicate, "and shall upon demand * * * communicate and explain * * * such improvement, addition, or discovery, and the" Elmore Syndicate "shall be entitled to every such improvement, addition, or discovery whether the same shall be patented or not."

Under this agreement Hay, Webster, and Ballot exercised their rights of option during a period of 11 months. Ballot or his consulting metallurgists, Sulman & Picard, attended at the works on almost every working day during that period. As they were treated with the greatest frankness they became fully acquainted with every detail of the process, plant, and working.

The option was not exercised.

Ballot's name was subsequently joined with that of Sulman & Picard on the patent of 1905 and he and Webster, with some friends, formed a syndicate, the original of the present Minerals Separation Limited, which acquired the Cattermole, Froment, and Sulman, Picard, and Ballot patents.

Legal action was started by the Ore Concentration Company (owners of the Elmore patents) in 1905 to enforce the provisions of Clause 7 of the agreement quoted above. The Ore Concentration Company lost in the first Court; they appealed asking for a new trial which was granted. After the hearing of the new trial had proceeded for several days the judge, as I understand it, raised the question as to what the position would be if Ballot had "made or become entitled to the improvements in or additions to the said invention," not on his own behalf but on behalf of the Syndicate of which he was a member.

In view of the fact that the judge was Mr. Justice (now Lord) Parker, doubtless the "Law" thus hinted at was very good; but the common-sense view of the matter may be left to the judgment of common-sense people.

At any rate, on this hint the parties to the suit consulted and the action was "settled by consent and by way of compromise and settlement of all claims arising

in respect of agreement of October 8th, 1901, both past and future, all proceedings stayed, each party paying his own costs."

There was not in this suit any question of validity of Elmore patents, and presumably because of that fact the proceedings have not received the attention they deserve. The case is quoted simply to draw attention to some interesting evidence given and as showing how extremely difficult it is for an inventor to protect himself.

The clause was drawn by one of the best legal firms in this country, and I believe the real meaning and intention of it is perfectly clear to the ordinary business man. Yet it took five judges, three courts, twelve learned counsel, and four firms of solicitors a period of two years to bring about the settlement above stated.

What a splendid justification for Molière's lines:

"There, take," says Justice, "take ye each a shell;

We thrive at the Law Courts on fools like you.

'Twas a fat oyster! live in peace—adieu."

Another protracted law-suit was commenced by the Ore Concentration Co. in Germany in the year 1906. It took the form of an opposition to the grant of a German patent applied for by Messrs. Sulman, Picard, and Ballot. The application was for a patent in substance the same as the main Minerals Separation patent in England.

The fight lasted for about three years; after hearing evidence and seeing experiments made, the German Patent-Office decided in July 1909 that the application of Minerals Separation disclosed no new feature to differentiate it from Elmore's earlier patent and consequently refused the grant of a patent to Minerals Separation.

I believe this suit is little known and attention is called to it in view of the importance of the decision arrived at by the German Patent-Office and because of the completeness of the historical record set out in the documents.

The following is a translation of the claim in Elmore's German patent:

"Process for the separation of the metallic from the mineral constituents of pulverized ore by mixing the latter with water and oil, characterized by the addition to the pulverized ore of water in at least such quantity that the mixture becomes very mobile, and the pulverized ore is freely suspended in the water."

Then, in the year 1907, Minerals Separation entered action against the Ore Concentration Company alleging infringement of Froment's patent (which had been bought by them for a trifling sum), dated 1902. The defence was anticipation by Stanley Elmore's acidulation patent of 1901 and prior public use by the Ore Concentration Company. The result was that in 1909 the Minerals Separation company gave notice that they wholly discontinued the action and paid the costs of the Ore Concentration Company.

In view of the decision of the German Patent-Office, establishing priority of the Elmore patents in which small quantities of oil and violent agitation are used over the application of Sulman, Picard, and Ballot, an

action was commenced in Germany in 1910, by the Ore Concentration Company (1905) Ltd. against the Metallgesellschaft claiming that concentrates produced in Australia by methods disclosed in Elmore's German patents and imported into the German Empire constituted an infringement of Elmore's rights under German law.

This action has not yet been prosecuted to a conclusion because of the difficulty first experienced of establishing the necessary exact legal chain of evidence connecting any particular sample of concentrate found in Germany with its production by the Elmore process in another country.

Similar actions will doubtless be started in connection with the importation of infringing concentrates into other countries.

To attempt anything like a comprehensive review of all the subsequent litigation the owners of the Elmore patents have been forced to commence in an endeavor to maintain the rights to which by general consent of a large number of independent authorities they are justly entitled, would occupy more of my time and more of your space than either of us might be inclined to give.

I would only like to say that throughout the whole of this weary litigation extending over years in England, Australia, and Germany, the validity, novelty, and utility of the Elmore patents have invariably been maintained, but by the incredulity and failure to grasp the importance of the Elmore invention by the mining industry in the early days have we as inventors and our sympathetic financial supporters been deprived of that monetary reward which should have been the result of the successful development of a revolutionary metallurgical process.

As it is, the world has been enriched by millions, the inventors have devoted 18 years of their lives to the development and introduction of this process, and they and their friends have expended some £200,000 in cash, without reasonable recompense of any kind. This record in a particular instance is distinctly discouraging to inventors and to those who are tempted to finance new inventions.

My own experience prompts me to say that till adequate reforms are introduced in the procedure by which patents are tested in the courts, till these courts are assisted by competent and independent skilled referees in matters of a scientific and technical character, in lieu of the present practice of calling a number of expert witnesses on each side whose evidence is generally conflicting and irreconcilable, it is an inhuman cruelty to foster in students a desire to cultivate any powers of inventions they may possess.

The above is my present contribution to the history of this invention. Some day I may find leisure to elaborate it into a real history worthy of the subject.

EXPORTS of tungsten ore from Japan in 1915 were as follows: United States, 85 tons; France, 214; United Kingdom, 110; total, 409 tons. The estimated shipments for this year up to July 20 were 480 tons, most of this amount being sent to the United States.

Mineral Industry of Japan

An interesting survey of the mineral industry during the past year as influenced by the War is given by Mr. Isobe, director of the Mining Bureau in the Japanese Department of Agriculture and Commerce. He says that the total value of the mineral output during the year amounted to 175,950,000 yen (1 yen = 50 cents), exclusive of the production at the Government Iron Works. This is a gain of 20,920,000 yen over the preceding year. The total value of metals produced amounted to 35,730,000 yen, or 57% above the previous year's figure. Non-metallic minerals on the other hand fell off by 15,280,000 yen mainly because coal was very inactive.

Gold and silver showed an increase by 16 and 5%, respectively, because of more active work at some mines. Copper was hard hit at first, but in March, 1915, trade was resumed owing to the demand by munition makers. Though the increase in production amounted to 7%, the increase in the total value is more than 37%.

Antimony showed an extraordinary boom in prices owing to the ever-increasing demand from munition makers. The volume of the output increased by 200%, while the value gained 8750%. Zinc went through the same vicissitudes as antimony, and at the close of the year the output showed an increase of 206% and the value, 805%. The completion of the plants of the Osaka Zinc Industry Co. and the Miike Zinc Refining Works during the year was largely responsible for this increase in the output. Coal was hard hit by the War, and restriction of production was made by Kyushu mines. The output decreased by 8% and the value 19%. Petroleum witnessed an increase of 11% in the output owing to a renewed gusher at Kurokawa, Akita, but the market presented no encouraging signs. Toward the end of the year there was some activity noticed, but the gain in value was only 5%. Sulphur decreased by 3% in the output and 5% in value, though toward the close of the year the market displayed a sudden activity, because all through the early period of the year production was heavily cut down at Hokkaido owing to the dullness of the market. —*Far Eastern Review*.

SOME Chilean nitrate statistics are as follows, according to a Consular Report, dated July 26:

	Quintals 1913-14	Quintals 1914-15	Quintals 1915-16
Production	62,322,617	34,091,243	57,715,614
Exports	58,751,291	32,070,714	55,285,814
To Europe and Egypt.....	44,534,131	16,939,650	29,017,777
To United States.....	12,290,782	13,437,418	23,484,842
East coast	11,222,657	12,295,221	20,390,839
West coast	1,068,125	1,142,197	3,094,003

Periods are for the years ended June 30. A quintal weighs 101.4 lb. Ordinary 95% nitrate is selling for \$1.77 per quintal, or \$35.40 per ton.

APPROXIMATELY one-half of the gold and silver contained in the ores of the Nevada Consolidated at Ely is recovered with the copper.

Amortization and Depreciation

By Robert S. Lewis

In this age of efficiency, little cause should remain for criticizing the reports of mining companies. Nevertheless, there is a noticeable lack of completeness in the figures of operating cost given by many of them. Allowances for amortization of capital and depreciation of plant are conspicuous by their absence, yet without them the true cost of mining and milling cannot be determined.

If a certain sum be invested in an enterprise that pays dividends for a number of years and then suddenly fails, the investor's gain or loss, as commonly computed, would be equal to the dividends paid less the sum invested. Assuming that the dividends exceeded the investment, they doubtless would have been considered wholly as income and not as composed partly of income and partly of a return of capital, which is their true nature.

When provision is made for the return of the sum invested, the process of redemption is called amortization of capital. Skinner¹ applies the term 'amortization' to the extinction of an interest-bearing debt, such as a bond issue, by equal annual payments or installments, but the question of interest complicates the case and need not be considered unless it is required. It is obvious that the life of the investment must be either known or estimated. This element of time is important and later will be considered at greater length.

Since a mine is a wasting asset—one that is of value only while being consumed—and is therefore of limited life, sound finance requires that the price paid should be returned to the purchasers at the expiration of the life of the mine, and that the profits from operation, in excess of this sum, should yield a satisfactory rate of interest. It is plain that both amortization and interest must come from profits, which are returns from the enterprise over and above the cost of operation, as this term is usually considered.

Hoover² states that it would seldom be possible to plan a definite policy of amortization, because the duration of the life of most mines is unknown, that mining companies never establish sinking-funds for the amortization of capital, and that should such a procedure be followed stockholders would prefer to do their own re-investing. However, several companies are now virtually amortizing their capital. Having recognized that their mines are approaching exhaustion they seek to prolong the life of the enterprise by purchasing other property. This practice is being adopted in the United States after having been applied successfully by English companies. Despite the great number of investors in mining shares,

it will be found that few understand the real nature of the income derived from their holdings and provide for amortization of investment; consequently a stopping of dividends means an impairment of their capital.

Two methods of calculating amortization have been used. The first creates a sinking-fund which will amount to the investment at the termination of its life.

Let C = the capital invested,
 r = the rate of interest that can be obtained on sinking-fund,
 n = the life in years,
 S = the annual payment to fund for amortizing capital.

$$\text{Then } S = C \left[\frac{r}{(1+r)^n - 1} \right]$$

Example: If \$250,000 is paid for a mine having an estimated life of 15 years, and 4% interest can be obtained on the sinking-fund, the annual payment necessary to amortize \$250,000 in 15 years is

$$250,000 \left[\frac{0.04}{(1.04)^{15} - 1} \right] = 12,500 \text{ in round numbers.}$$

The second method meets the requirement that interest on the sum invested is demanded during the period of amortization. Part of each annual payment goes to pay interest and the remainder is used to reduce the principal. Since interest for the year is computed on the reduced principal, this interest charge grows less each year and the reduction of principal becomes more and more rapid.

Using the same notation as above, except that r is now the rate of interest demanded on the investment,

$$S = C \left[\frac{r}{1 - \frac{1}{(1+r)^n}} \right] \text{ or } S = 250,000 \left[\frac{0.04}{1 - \frac{1}{(1.04)^{15}}} \right]$$

For a more detailed example of this method see 'The Cost of Mining,' by J. R. Finlay, page 45.

Skinner³ defines depreciation as "the loss in value of physical property, due to use, which cannot be made good by current repairs." Fish⁴ views depreciation in the light of the equation:

$$\text{First Cost} - \text{Depreciation} = \text{Salvage Value}$$

The first conception is of interest to the manager of the plant, since the charge for depreciation is a charge against operation, while the valuing engineer is concerned with the second conception, as it enables him to put a price on the property should an appraisal be required.

Depreciation results from a number of causes, which

¹'The Mathematics of Investment,' E. B. Skinner, p. 114.

²'Principles of Mining,' H. C. Hoover, p. 44.

³'The Mathematical Theory of Investment,' by E. B. Skinner, p. 149.

⁴'Engineering Economics,' by J. C. L. Fish, p. 48.

may be classified under two heads: physical decay and functional decay. The first may be predicted with a fair degree of accuracy, but it is a more difficult problem to forecast functional decay, meaning either inadequacy or obsolescence. Inadequacy indicates that a machine is not capable of fully performing the function which it was intended, generally by reason of expansion of the enterprise. Obsolescence brings a decrease in value by reason of the invention of a better machine or the discovery of a process not requiring the use of that particular machine. For this reason a new machine may suddenly become worthless though it is in perfect physical condition.

When depreciation is applied to the separate departments or units of a plant it is called 'unit depreciation,' while total or composite depreciation is applied to the entire plant, and is always the sum of the unit depreciations. Thus it is plain that 'unit' depreciation may reach 100% of the original value, but 'composite' depreciation increases to a certain point, say 15 or 20%, beyond which it does not go owing to the renewal of the units of the plant. While operating efficiency is ultimately dependent upon depreciation, a superficial consideration would show little relation between them. Thus ordinary repairs might maintain a concentrating-table at 100% operating efficiency for several years, until suddenly, like the 'One-hoss Shay,' the table went to pieces and had to be replaced by a new one. If proper provision for depreciation had been made, the sum accumulated should pay for the new machine. It is short-sighted policy to refuse to recognize depreciation because present operating efficiency is high. Depreciation on mining property should be calculated on the basis of future replacement rather than on future sale.

When worked-out a mine has no value, but the plant on the surface—such as hoist, offices, mill or smelter—has a scrap or salvage value that is dependent upon condition. Where machinery has been in use for ten years or more, many engineers consider that it has no salvage value. The hard pace at which it has been driven, the long distance it would have to be transported to a new plant, and the fact that it is unlikely to be the most suitable machinery to use tend to extinguish its money-value. Second-hand mining machinery generally proves to be the most expensive that could be bought.

After a new plant has been brought into a condition of steady operation, current repairs reach an approximately uniform figure. There should be no great difference from year to year, though repairs tend to increase as the plant becomes older. However, the replacement of a large amount of equipment or the making of changes involving heavy expense would place too great a burden on the revenue for that year if written-off in one sum. It is the purpose of depreciation to distribute this expense over a number of years and thus maintain a fairly uniform charge against operation. The only expense properly chargeable to capital account is that which results in increased capacity and earning power. The replacing of several machines by one capable of

doing the same work, the elevating of grinding apparatus in order to obtain the proper slope for launders, in short, all expense necessary to keep the plant up to date and in proper operating condition should be charged to depreciation, and not to capital.

Except in rare cases, it is not possible to predict the life of a mine. Even where reserves have been blocked out sufficient to last for 15 or 20 years, as in the large copper mines, later developments may greatly extend this period. For this reason calculations on amortization and depreciation are largely tentative and may require subsequent modification, but such charges should be made if the real operating expense is to be ascertained. The elements entering into a particular case require careful study in order to make the estimate as reliable as possible. Changes may then be made when necessary.

The life of machines under given conditions may often be estimated quite accurately. The mortality-tables of life-insurance companies prove that reliance may be placed on the law of averages, though individuals show a wide divergence from the average. Having this in mind, the Railroad Commission of the State of Washington has constructed a mortality-table of structures that has been useful to them in their work of valuation. If mine and mill superintendents would keep detailed records of the machinery under their charge and publish the figures, depreciation would soon be recognized as a legitimate and necessary account instead of being accorded the erratic attention it now receives.

The importance of an account for depreciation is well illustrated in the paper by P. W. Henry⁵ where he states "that a proper depreciation charge may be equal to or greater than the direct cost per barrel, will doubtless surprise many investors in oil properties who consider only immediate expense and immediate profit without regard to the safety of the principal invested." In certain cases a fair depreciation charge would be 4% on the cost of oil-lands, 7% on the cost of field-equipment, and 10% on the cost of individual wells and appurtenances. Under the Income Tax Regulations of 1913, a depreciation charge for depletion of ore reserves may be made, not to exceed 5% of the gross value of the year's output at the mine. In addition, an allowance for depreciation of plant is permitted.

Actual depreciation does not follow any fixed law, but estimates made after a careful study of conditions are sufficiently accurate for practical purposes. Unit depreciation must first be found, and then the total or composite depreciation for the entire plant can be calculated. Since depreciation is based upon cost, only one kind, either physical or functional, should be used for a given unit, and this should be the greater of the two. The other is ineffective. Evidently total or composite depreciation would be made up from a number of unit depreciations, some of them physical and some functional, for all units would not depreciate in the same manner.

⁵'Depreciation as Applied to Oil Properties,' read at New York meeting of A. I. M. E., February 1915.

The most common methods of determining theoretical depreciation are given below.

STRAIGHT-LINE METHOD: This is the simplest of all methods, and has been much used because of the ease with which it can be understood and applied. It is based upon the assumption that the annual charge for depreciation is the quotient that results from dividing the cost by the life in years.

Let V_c = the cost,

V_s = the salvage-value,

n = the life in years,

D = the annual depreciation charge,

$$\text{Then } D = \frac{V_c - V_s}{n}$$

Assuming that a Chilean mill costs \$2000 and has a life of 10 years, the annual depreciation charge is $2000 \div 10$, or \$200. The annual charges are equal and no interest charges are involved, neither are logarithms required for the solution. However, as it is based on a fixed procedure, it does not show how the depreciation actually occurs nor does it consider various factors that may exert at any time a marked effect on the charge for depreciation. Then, too, unless a separate depreciation account is kept for each machine in question, constant reference to the original cost is required, since the yearly record of depreciation does not require that this figure be stated.

REDUCING BALANCE METHOD: This is another method that is not complicated by interest calculations. Using the same notation as above, the formula is $D = 1 - \frac{n}{V_c} \sqrt[n]{V_s}$.

D in this case is to be taken as the percentage by which the balance must be reduced each year. Since the problem is indeterminate when the salvage value is zero, a nominal figure such as \$1 should be used. Thus for the above example $D = 1 - \frac{10}{\sqrt[10]{2000}} = 0.5324 = 53.24\%$ = \$1064.80 for the first year.

It is evident that this formula gives a diminishing annual charge for depreciation, which is claimed to be in accord with economic facts. Since the yearly repairs usually increase as the machine grows older, the annual charge for repairs plus depreciation against operation becomes nearly constant. However, this method involves a complicated mathematical calculation and the rate obtained gives little indication of the period required to write-off the investment. Furthermore the high charge during the early years of operation may be serious for a new plant, when profits are often meagre. Though the high rate obtained must be far in excess of the actual rate of depreciation, it is claimed that this rapid writing-off removes the possibility of a failure to establish an adequate reserve, but there is danger of creating a secret reserve from this under-valuation of assets.

SINKING-FUND METHOD: This method has been advocated by many writers. As the name indicates, equal annual installments are set aside at compound interest until the accumulated sum is equal to the depreciation. The longer the term during which the fund is accumu-

lating, the larger become the contributions earned from interest. Thus it would seem that the cost of creating such a fund would grow less with the increase in the number of years required. As the contributions to the fund are necessarily taken from the business, the business must not be very prosperous if money can earn more when placed in a sinking-fund than if used in the business.

$$\text{The formula is } D = V_c \left[\frac{r}{(1+r)^n - 1} \right]$$

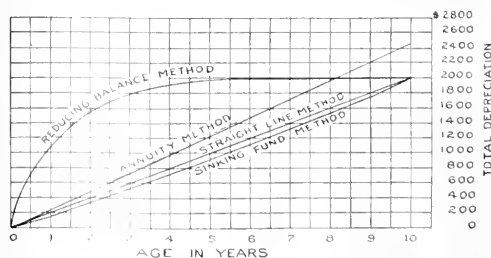
where D is the annual contribution to the sinking-fund and r the rate that is paid on the fund. Returning to the example given above and assuming 4% on interest,

$$D = 2000 \left[\frac{0.04}{(1.04)^{10} - 1} \right] = \$166.66 +. \text{ This is the same as the first formula given under amortization.}$$

ANNUITY METHOD: In the methods thus far discussed, the question of interest on the investment has not been considered. In the annuity method a constant sum is set aside each year. This sum when deducted each year from the remainder of the investment plus interest will write off the investment and also return interest on the investment during the period in question. $D = (V_c - V_s) \frac{(r-1)}{(r^n - 1)}$. In this case r = rate plus 1. Since $V_s = 0$, $D = 2000 (1 + 0.04)^{10} \left[\frac{1.04 - 1}{1.04^{10} - 1} \right] = \$246.66 +.$

Since the interest is calculated each year on the reduced value, it follows that as the interest charge decreases the allowance for depreciation necessarily increases, since the sum of the two equals the yearly payment. The need for allowing for interest is more apparent than real. In any properly-conducted business, part of the net profit represents interest on the investment, and to require interest when the depreciation account is created and maintained from profits is to duplicate the charge for interest.

The results of calculating depreciation by the above methods have been plotted in the accompanying chart.



The curves show the total depreciation fund as it accumulates from year to year. Two other methods should be mentioned in passing: the equal annual payment method proposed by the special committee on valuation of the American Society of Civil Engineers, and the unit-cost method. Both are more complicated than the methods given above. They are fully explained in Salier's 'Principles of Depreciation,' to which work I wish to acknowledge my indebtedness.

Cupellation Losses in Assaying

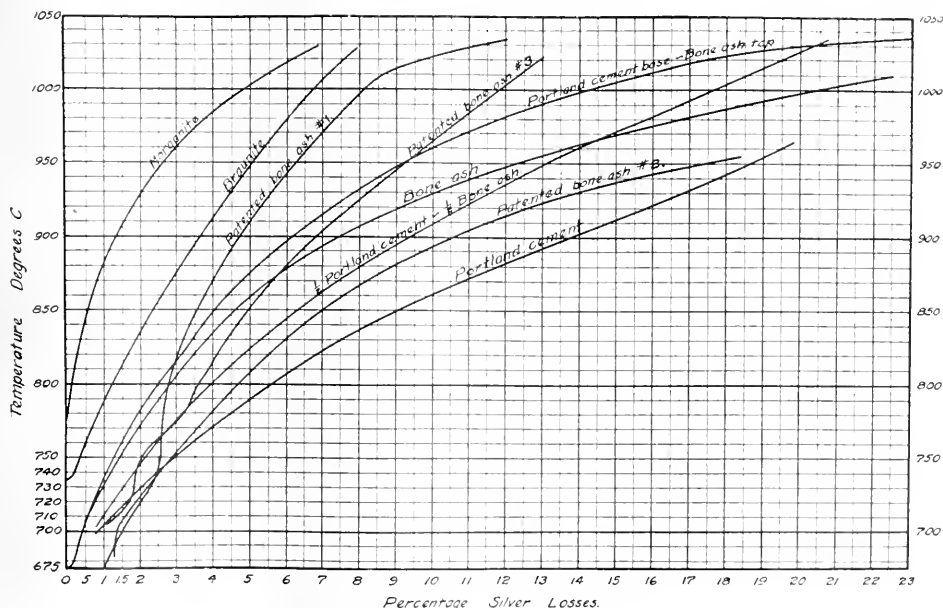
*This subject has occupied the attention of many assayers, especially where silver ore and bullion are being tested. The results tabulated and summarized in the 54 pages of this publication are those of H. T. Mann and C. Y. Clayton, assisted by J. A. Taggart and A. F. Karte. The investigation was a thorough one.

Temperature, material in cupel, impurities, and other factors affect the loss of precious metals. In their experiments, the authors weighed a certain amount of silver foil and wrapped it in lead foil, the latter being weighed to the nearest half gram. A muffle in a gasoline furnace was used for cupelling. Each test consisted of

The charge for each cupel was 20 gm. lead and 20 mg. silver. The cupels used were of boneash, half cement and half boneash, cement base with boneash top, cement, Morganite, Braumite, and three patent cupels.

The effect of the amount of moisture and the hardness of cupels on the silver loss was next investigated. Five sets of cupels were made from boneash containing 5, 8, 12, 17, and 22% of moisture, respectively. One lot was made very soft, the next soft, followed by ordinary, hard, and very hard. Cupellations made in these showed that the amount of moisture and their hardness had little effect on the loss of silver. The very soft cupels finished a little ahead of the hard ones.

Other tests proved that the surface condition of the



CURVES SHOWING LOSSES OF SILVER DURING CUPELLATION, USING DIFFERENT MATERIALS.

five rows of six buttons in each across the muffle, the first row three inches from the front, this row only acting as a shield for the others. The cupels were heated to 925 or 950 °C. before placing in the buttons. Until all the buttons were molten the muffle door was kept closed. Then it was opened, and the temperature of the cupellations lowered by reducing the muffle temperature, also by 'coolers' put in the muffle. 'Feathers' of litharge formed around the cupel. This heat was held until a minute before the 'blick,' when the coolers were withdrawn and the furnace temperature raised so that the cupellations finished at between 850 and 900°C.

Of the boneash used in the cupels 21.7% passed through a 260-mesh screen, while 14.2% remained on 65, 22.5% on 100, 9.3% on 150, and 16.2% on 200-mesh.

*Abstract from Bulletin of the School of Mines, University of Missouri, at Rolla.

cupel has little or no effect on silver losses; that is, whether the surface was well glazed or rough.

It was thought that the size of the boneash may affect the losses, but many cupellations showed that, provided the boneash passes 60-mesh, the size of the particles makes practically no difference. The time of cupellation with different sizes of ash was almost the same.

The final experiments were made to determine whether any losses were due to the chemical composition of assay slags. The conclusion arrived at was that under ordinary conditions of assaying the chemical composition of the resulting slag has very little effect on the silver recovery, provided the four requirements of a good fusion are fulfilled, namely: complete decomposition of the ore, formation of a fluid slag, furnishing the proper amount of collector (lead) at the proper time, and keeping out of the lead button undesirable impurities.

Notes on Flotation

By Rudolf Gahl*

COAL-TAR AS FLOTATION AGENT

It was to be expected, when the flotation process was installed in our test-plant, that there would be ups and downs in the recovery because the process was rather new, especially in its application to chalcocite ores. For the month of June 1914, the recovery obtained in the test-mill showed a sudden drop, and the serious problem confronted us of establishing the cause and finding a remedy. Some of the flotation experts suggested that it might be due to the fact that a new shipment of cresylic acid might not fill the specifications of being 98% pure. We did not feel competent to say whether the impurities actually amounted to more than 2%. We were, however, inclined to think that perhaps cresylic acid, which is one of the products resulting from fractional distillation of coal-tar, might not represent the fraction most suitable for the flotation of our ores. Having no coal-tar available, we proceeded to make some by distilling a sample of ordinary New Mexico soft coal and separating the tar thus formed into the fractions distilling off at different temperatures.

Our facilities for testing oils were limited. The Minerals Separation representative did not believe in small-scale tests, and for this reason did not recommend experiments with small testing-machines. Nevertheless, it seemed desirable to have something with which to carry out small-scale laboratory experiments. Dr. L. D. Ricketts, who was aware of our troubles and realized the importance of such tests, was kind enough to send us a little electrically-operated emulsifying machine, which served admirably for qualitative tests. We also built a testing-machine based on the principle of the standard Minerals Separation machine, with the difference, however, that instead of sending the pulp from one agitating-compartment to a spitzkasten and then into another agitating-compartment and spitzkasten, we made the pulp return from the first spitzkasten to the original agitator, forcing it to revolve in a closed circuit. Lately, a machine based on the same principle has been put on the market and is sold by the Denver Fire Clay Co. Thus, we had a chance to try the different fractions of our home-made coal-tar.

The chemist who conducted these tests (Mueller) hit on the idea that it might be well, in addition to trying the different fractions, also to test the coal-tar as a whole. The results were surprising, since they showed that by the addition of crude coal-tar we could effect a

greater recovery than we were able to obtain by the use of highly refined cresylic acid. From this point dates our experience that it is better to use coal-tar than soluble flotation agents like cresylic acid to save coarse mineral. Cresylic acid is an extraordinarily good agent for producing froth, but the froth does not seem to have as much carrying power for coarse mineral as that produced by coal-tar. Not all coal-tars are equally good for this purpose. Tests in laboratory machines easily show the difference between coal-tars of different origin.

It is difficult to utilize coal-tar in plants using flotation supplementary to gravity concentration, on account of the fact that it is not easy to effect a good amalgamation of tar with the pulp in agitating-tanks, and even in mechanical flotation-machines. The use of coal-tar lends itself very well indeed to the system of feeding tar into the grinding machines, a system that, as mentioned above, had been worked out in our small test-mill and patented by G. A. Chapman.

The company is indebted to Mr. J. M. Callow for proving the merits of coal-tar creosote as a flotation agent by using it in his demonstration plant at Inspiration. After we had established the value of coal-tar by laboratory tests, and while efforts were being made to obtain it commercially, he applied creosote successfully. We have continued to use it for a long time, mostly in combination with coal-tar, and have only recently dropped it, as we find crude coal-tar cheaper and better.

INFLUENCE OF IRON ON FLOTATION

While these tests were in progress, we made another useful discovery. In our tests on the most economical way of reducing the ore to the fineness necessary for flotation, we had, among other machines, a ball-mill in competition with pebble-mills. In the ball-mill, steel balls performed the duty that in pebble-mills was done by flint pebbles.

For a while, the ball-mill discharge was treated on one flotation machine, while the pebble-mill discharge was treated on a group of others. While this flow-sheet was being followed, we thought we noted that a flotation machine treating the ball-mill product showed the influence of the primary slime to a less extent than the flotation machine treating the pebble-mill product. In a discussion with Dr. Ricketts and Mr. Mills, the question was raised as to whether the iron introduced in the pulp by the attrition of the balls might not have something to do with the fact. The question was accordingly made the subject of some laboratory experiments. The results of a series of such experiments are represented in Table I herewith, and proved conclusively that the iron had a beneficial influence on flotation in counter-

*Excerpts from paper entitled 'History of the Flotation Process at Inspiration,' to be presented at the Arizona meeting of the American Institute of Mining Engineers (September 1916).

acting the harmful effect of the primary slime. This discovery was one of the inducements for installing ball-mills in the big concentrator plant, while originally pebble-mills had been considered for this purpose.

proved by the use of the magnet. If necessary, the effect of the iron could be increased by removing the iron contained in the tailing by means of electro-magnets and returning it to the mills or the flotation machines.

TABLE I

Test No.	Grams Ore	Per Cent. Copper	Grams Copper	Concentrates			Recovery, Per Cent.	Remarks
				Grams	Per Cent.	Grams Cu		
F21	750	2 01	15 07	45	23 66	10 65	70 7	Added 10 g. iron filings.
F22	750	2 01	15 07	47	29 52	11 52	76.4	Added 10 g. iron filings.
F27	750	2 01	15 07	43	27 10	11 65	77 5	Added 2 g. iron filings.
F28	750	2 01	15 07	47	26 90	12 64	84 0	Added 2 g. iron filings.
F45	750	2 01	15 07	31	23 84	12 16	80.7	Added 10 g. iron filings.
F46	750	2 01	15 07	48	25 60	12 29	81 5	Added 10 g. iron filings.
F47	750	2 01	15 07	27	8 80	2 38	15 8	Blank with no solids added.
F48	750	2 01	15 07	28	8 34	2 34	15 5	Blank with no solids added.
F49	750	2 01	15 07	62	20 14	12 49	83 0	Added 10 g. miscellaneous iron filings from shops.
F50	750	2 01	15 07	63	20 10	12 66	84 0	Added 10 g. miscellaneous iron filings from shops.
F51	750	2 01	15 07	60	18 82	11 29	75 0	Same as F49 and F50 by different observer.
F52	750	2 01	15 07	62	19 54	12 11	80 5	Same as F49 and F50 by different observer.
F53	750	2 01	15 07	29	6 16	1 79	11 9	Blank with no solids added.
F54	750	2 01	15 07	30	7 96	2 39	15 9	Blank with no solids added.
F55	750	2 01	15 07	59	21 08	12 44	82.7	Added 10 g. iron filings.
F56	750	2 01	15 07	56	25 80	14 45	96 0	Added 10 g. iron filings.
F64	750	2 01	15 07	65	19 52	12 69	81 9	Ground in mill with steel balls instead of pebbles.
L27	750	1 10	12 75	37	28 42	10 51	81 7	Blank on good flotation ore.
L28	750	1 10	12 75	34	28 46	9 85	78 3	Blank on good flotation ore.
L29	750	1 10	12 75	76	5 66	4 30	33 4	Identical conditions as L27 and L28 but added 10 g. zinc filings.
L30	750	1 10	12 75	83	5 06	4 20	32 9	Identical conditions as L27 and L28 but added 10 g. zinc filings.

We have not yet reached a point where we can safely give the reason for the action of the iron introduced into the pulp. It is sure, from the experiments, that the same results as by grinding with balls could be obtained by introducing the iron in finely divided form, say in the form of filings, into a pebble-mill pulp. We supposed for a while that the metallic iron might react on the impurities contained in solution in the mill-water and introduced therein with the primary slime. We find, as a matter of fact, that our ore contains little in the nature of soluble salts, and that whatever it does contain is mainly confined to the primary slime. For this reason, in laboratory tests we have tried repeatedly to substitute pure water for the water contained in the pulp. In every case, we have noted some improvements in results. We have also found that when we separate the water from the refractory pulp, treat it with iron filings, and add it to the original pulp again, we get a certain improvement in the recovery, but we have not been able to get an improvement equally as good as that obtained by direct introduction of finely-divided iron. For this reason, we have often thought that the effect of iron is physical rather than chemical. The iron exists in the pulp, at least partly, in the metallic form, as can be

ore containing a high amount of oxide, such as surface ore, is correspondingly lower. We have worked in the laboratory with the object in view of increasing the oxide recovery; for instance, by adding certain chemicals to the pulp, but we have not yet applied this method to

TABLE II

Flotation Feed					General Tails							
Mesh	Per Cent Weight		Copper Contents		Per Cent. Weight		Sulphide Cop- per Contents		Oxide Copper Contents		Total Copper Contents	
	Cum.	Indiv.	Per Cent	Grams	Cum.	Indiv.	Per Cent	Grams	Per Cent.	Grams	Per Cent	Grams
+ 65	9.5	9.5	0.45	0.042	9.5	9.5	0.18	0.017	0.12	0.011	0.30	0.028
+100	21.2	11.7	0.86	0.101	21.2	11.7	0.19	0.023	0.14	0.016	0.33	0.039
+150	33.5	12.3	1.91	0.235	33.5	12.3	0.11	0.014	0.19	0.023	0.30	0.037
+200	39.2	5.7	2.69	0.154	39.2	5.7	0.14	0.008	0.19	0.011	0.34	0.190
-200		60.8	1.85	1.125	....	60.8	0.06	0.036	0.47	0.286	0.53	0.322
Totals ....	....	100.0	....	1.657	....	100.0	....	0.098	....	0.347	....	0.445
Assay direct	....	....	1.62	....	....	....	0.101	....	0.318	....	0.419	....
Oxide .....	....	....	0.36									

an operating scale, nor have we decided on using one of the other methods applicable for this purpose, such as leaching.

The table shown above gives an average screen-analyses of the feed and the general tailings of the In-

spiration concentrator for the months of March, April, and May. A segregation is made in the copper assay between sulphide and oxide copper, because, considering the present stage of the art, we feel satisfied with our work whenever the sulphide copper content of the mill-tailing is low. As will be seen from the tabulations, a better recovery is made on the -200 material than on the coarser constituents of the ore, which proves the point that for ores of this character sliming is no longer to be feared. There was little variation in the copper-oxide content of the tailing from the material of different sizes coarser than -200 mesh.

OIL CONSUMPTION

Experience has shown that we consume up to $1\frac{1}{2}$ lb. per ton of ore. At present, the oil mixture contains around 95% crude coal-tar and a little less than 5% of oil derived from the dry distillation of wood.

The different tars that we have tested during the operation of our mill have shown greatly varying qualities as far as their flotation value is concerned. The first tar that we used was home-made from domestic coal, and happened to be a serviceable flotation agent. Since that time, we have tested tars from several States. We have obtained satisfactory tar-products from New Mexico, Colorado, Missouri, and Illinois. These States furnish at present as much as we need for our consumption. For awhile, it seemed possible that we might have to import from a long distance the large quantities of tar that we require. During that period we tried to find substitutes, and looked especially toward the utilization of fuel-oil for this purpose, but we have not been able to get as good results with any kind of fuel-oil as with crude coal-tar.

Our experience is that we can get along with coal-tar alone. It is beneficial, however, to add wood-distillation products in small quantities, for instance, those containing pine-oil. While coal-tar makes a strong and heavy froth, such as appears to be required to keep coarse mineral particles in suspension, the wood-distillation products have the characteristic of producing a multitude of bubbles, such as seem necessary to furnish the large surface required to save the finest mineral particles. Because the finer ore particles expose a large surface, it is evidently necessary to produce a correspondingly large surface of froth in order to save them by flotation.

OPERATING COST

The number of men necessary for the operation of large flotation machines is remarkably small. At the Inspiration plant, one operator supervises four sections of flotation machines. Two Mexican helpers assist him in washing the bottoms, thus insuring a free passage of air through the porous medium. At the prevailing high prices of American and Mexican labor, this means an expense of somewhat more than 1.5c. per ton of ore treated. The total expenses representing flotation proper were as follows for the months of March, April, and May, 1916:

	Cents per ton
Labor	1.62
Oils	1.65
Other supplies	0.35
Power	2.14
Total	5.76

The subsequent table treatment of flotation tailings, the filter treatment of the concentrates and other operations connected with the process of concentration, belong more or less to flotation treatment, and their expense should also be considered when the cost of the flotation process is to be established. The total milling cost, exclusive of crushing and grinding, has been for the past few months in the neighborhood of 20 cents. When the cost of crushing and grinding is included, the cost is about 40c. per ton of ore. Royalties for the use of the flotation process are not included in any of these cost figures.

Iron as a Barometer of Industry

There is such a disposition in some quarters to regard the activity of the iron and steel industry as being based chiefly on the War demand for steel, it might be inferred that iron is not at this time the barometer of general trade; but the statement can be defended that iron and steel activity is at this juncture as close a reflection of general trade activity as has been the case at various times in the past. The production of steel ingots is at a rate considerably more than 40,000,000 tons per year, against only 30,000,000 tons in 1912 and 1913, hitherto the best years, and the War demand for steel does not account for all of the excess tonnage. Another and very important factor must be considered. There have been times when such general business activity as existed ran largely to new construction work, a line in which steel is particularly prominent. At such times the steel industry was more active than were many others, and if taken as a barometer it rather exaggerated the degree of general prosperity. At the present time the divergence is in the other direction. The employment of steel for strictly new construction is relatively small, and the consumption of steel for various miscellaneous uses, more directly and closely associated with the activities of the people, is relatively large. The function of the barometer, however, is not to tell of an existing condition, but to furnish means for a forecast, and it may be inquired what light the state of affairs in the steel market throws upon the question, how long the War is to last and how long business activity is to last. If one is to judge by the attitude of buyers of steel he may be confused, for some buyers are taking a decidedly conservative, if not pessimistic, view of the future of their particular lines, if high prices for steel are to continue indefinitely. Others are buying with confidence. If we are to judge by the attitude of steel producers there is no occasion to be confused. The steel producers are engaged in new construction, and prosecuting it when costs are extremely high.—*The Iron Age*.

Sinking Through Sand

By Edward A. Sayre

*A common method of sinking through difficult ground employs a steel shoe pushed ahead of the shaft-timbers; another is the drop-shaft method. These two methods were used at the Eagle No. 3 mine, Des Moines, Iowa, and the following data show the relative cost of the two methods under the same conditions. The material to be penetrated was 73 ft. of drift and sand, including several clay streaks.

STEEL-SHOE METHOD. The method of sinking the main shaft by the steel-shoe method was to agitate the sand and force the shoe through it by means of jack-screws. Two methods were used to agitate the sand. First, while the men could reach the bottom of the shoe, they stirred the sand with spades. Later the pumping system was used. The discharge of the No. 6 Cameron pump could, when desired, be sent through five $\frac{3}{4}$ -in. pipes, and the five jets of water could be played upon the sand at the bottom of the shoe. It was found that these jets would agitate the sand sufficiently to permit the jack-screws to push the shoe down, except when the sand was at too high a level inside the shoe, in which case sand would have to be excavated before the jet process could be resumed. In using this process the men would stir the sand with the jets for about 10 min., and then tighten the jack-screws. When sufficient space was obtained between the timbers in the shoe and the curbing above, the two jack-screws of one side were removed, and timber put in place on top of the timbers in the shoe, and then the other jack-screws were moved. An advance of 18 in. per day was exceptional, more often it was less than a foot.

Necessarily some sand had to be excavated. This tended to cave the dirt around the shaft, which in turn caused an excessive down pressure and broke the curbing. An attempt was made to overcome this by supporting the curb with I-beams and cables from the surface. Ten 12-in. beams were supported on cribs at the surface, and ten 8-in. beams were swung under the angle below the ties, being connected by twenty $\frac{3}{4}$ -in. steel cables. When the sinking was resumed, the curbing continued to break, the I-beams bent, and two cables were broken. Since it appeared impossible to hold the curb, it was decided to timber the shaft solid from the 8-ft. level (where the most uniform break occurred) to the bottom of the shoe, and then drop this portion of the shaft through the remaining 5 ft. of sand.

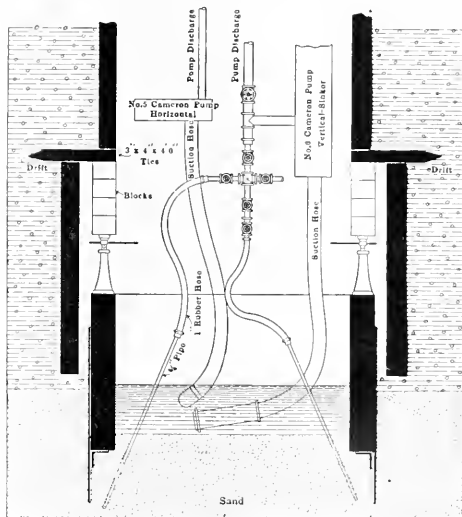
To do this, the ties were driven back into the wall and solid timbering put in between the shoe and the upper curbing of the shaft. The entire shaft curbing from the 8-ft. level down was then tied together with 2 by 6-in. stringers. At the 8-ft. level planks were spiked to the lower curb, the upper ends projecting above the break preventing the loose material from falling. The

jet system, using occasional excavation of sand, was resumed, and the shoe, with 50 ft. of curbing, was lowered.

In landing the shaft on solid rock, seven boulders 1 to 2 ft. in diameter were encountered. Six of these were under the cutting-edge of the shoe, and were removed only after being broken by chisel and sledge.

While lowering the shaft through the last 5 ft., the upper timbers buckled 18 in. out of line. This necessitated re-timbering from the sand to the surface, an expensive undertaking because the old timbers had to be cut out and replaced in sections.

On completion of the re-timbering, sinking through the shale was commenced. Three shifts were used making a daily advance of 5 ft. The only problem in the shale was the elimination of the water, most of which stopped



STEEL-SHOE METHOD USING JACK-SCREWS.

when the solid rock was reached. This water was taken care of by placing a water-ring at the 85-ft. level with a pump to elevate the water to the surface.

DROP-SHAFT METHOD. The air-shaft was located 350 ft. from the main shaft, and conditions were similar except that the surface at this point was 10 ft. lower, making the distance to be traversed to rock 63 $\frac{1}{2}$ ft. The equipment was the same used at the main shaft. The air-shaft followed a drill-hole tapped by an entry from the main shaft, so that most of the water was drained through this hole and then pumped to surface. The steel shoe was similar to the one in the main shaft, except that it was 10 ft. high instead of 5 ft. The timbering for the first 30 ft. above the shoe consisted of 4 by 6 members laid flat, tied together by $\frac{3}{4}$ -in. lag-screws 10 in. long, spaced 2 ft. apart. The shaft was divided into three equal compartments by 4 by 6 buntons. The middle compartment was left free and was used for hoisting.

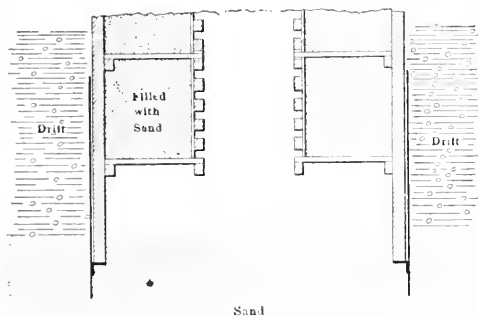
An excavation 10 ft. deep was made, the shoe assembled and lined with timbers. Sinking was continued until

*Abstract of paper prepared for the Arizona meeting of the American Institute of Mining Engineers.

the shoe was hung up by the friction on the sides. Then a platform was built every 5 ft. in the end compartments. These 5-ft. chambers were filled with sand to give additional weight, and sinking continued. The ground surrounding the shoe gradually broke in an oval shape. At one place it was necessary to fire a small charge of powder in order to loosen the ground sufficiently at one end of the shaft. As the shoe was sunk, timbers were added at the top of the curbing. This method of building the curb at the top is better than that of adding at the bottom since the timbers are placed more expeditiously.

One difficulty experienced was to keep the bottom of the shoe level. When one side got lower than the other it kicked the opposite side onward. To right it, the lower side was blocked until the higher side caught up. This greatly reduced the trouble.

The progress through the drift material, until the sand was reached, was slower than at the main shaft.



DROP-SHAFT METHOD.

The drop-shaft went faster, however, after reaching the sand. In fact, the difficulty at that time was to keep the bottom of the shaft from moving faster than the top. When within 10 in. of the bottom of the sand, the shaft broke apart 20 ft. from the shoe. This was due to the movement of the shoe being faster than that of the top of the shaft, and to the insufficient strength of the straps connecting the top and bottom of the curb. At this point (20 ft. above the shoe) the curb separated from 6 to 8 in., and the upper part of the shaft kicked over 9 in. A temporary platform of 8 by 8 timber was put in the end compartments and time given for the upper part to settle before starting again. Sinking was then continued and the shoe landed on the solid without further difficulty, aside from hitting two small boulders at the bottom of the sand.

As the excavation was larger than necessary for an air-shaft, it was decided to cement the shaft for a distance of 28 ft. from the bottom of the shoe, in order to stop the water. A wall of cement 4 to 8 in. thick was accordingly constructed. After the cement was given time to set thoroughly, the excavation was again started in the shale and continued without difficulty to the coal. Sinking through the shale in the air-shaft cost slightly

more than in the main shaft because work in the mine prevented careful supervision being given.

One difficulty, encountered in drop-shaft sinking, was in keeping the position of the shaft vertical. At one time this shaft was 2 ft. out of plumb. By regulating the movement at the bottom of the shoe, the shaft partly righted itself, until at the finish in a total depth of 63½ ft. to the shale the bottom of the shaft was 16 in. to the south and 10 in. to the east of the top. Part of this variation was remedied in the cementing.

A much larger amount of sand was removed in sinking the air-shaft by the drop-shaft method than in sinking the main shaft. This could be done without danger of a cavity forming, because the surface dirt followed the air-shaft down. When sinking through the sand was completed, the surface directly surrounding the air-shaft had caved to a depth of 15 to 16 ft. and for a distance of 20 ft. in all directions. In fact, all the shale that was removed through the remaining 92 ft. to the coal did not fill this space at the surface.

A comparison of the two shafts is shown below. The main shaft was sunk 92 ft. by the steel-shoe method, the air-shaft was sunk 82 ft. by the drop-shaft method.

Labor:	Main shaft	Air-shaft
Through drift material	\$917	\$789
Through sand	1,942	542
Through shale	1,065	1,213
	<hr/> \$3,924	<hr/> \$2,544
Superintendence	600	435
Re-timbering	1,343	....
Cementing .....	....	208
	<hr/>	<hr/>
Total labor cost	\$5,867	\$3,187
Materials:		
Curbing	\$1,879	\$1,195
Supplies	900	643
Power, light, water, insurance, etc....	1,249	650
	<hr/>	<hr/>
Total curbing, etc., cost	\$4,027	\$2,487
	<hr/>	<hr/>
Total costs of shafts	\$9,894	\$5,674

CONCLUSION. There was no question of the superiority of the drop-shaft method. It made a net saving of \$4300 in the total cost of the air-shaft compared with the main shaft. A saving of \$2700 was effected in labor, while in the cost of materials, power, etc., the saving was \$1600. A saving in time also ensued, 30 days being required to traverse the sand with the main shaft, while the air-shaft was dropped through in 17 days. The drop-shaft method seems to be the safest, most economical, and most successful that can be adopted for sinking through soft material that lies within 100 ft. of the surface. At greater depths a variation of the method can be used by first sinking a larger shaft close to the soft material, and then telescoping a drop-shaft within it.

SMEETING operations at the Mt. Morgan mine, Queensland, Australia, are improving. One furnace had a continuous campaign of 54 weeks. The matte gravity system is giving satisfaction. It required 52.46 tons of ore to yield 1 ton of blister copper.

Dredging in Montana

By Hennen Jennings

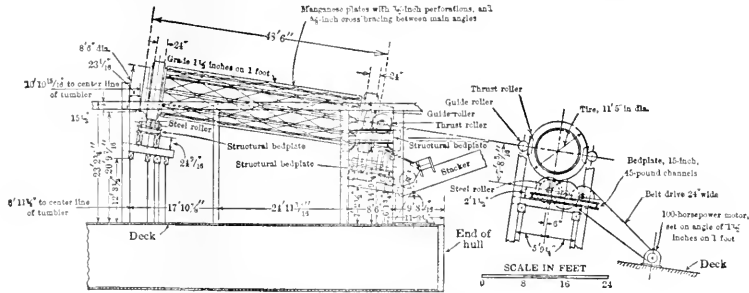
The history and development of gold dredging in this State is described in Bulletin 121 of U. S. Bureau of Mines by Mr. Jennings, who is consulting engineer to the Conrey Placer Mining Co. Mention was made of this company's work by him in an interview published in the PRESS of December 25, 1915. Some of the early dredging appliances used in New Zealand and California are summarized in the introduction, the first dredge having been built on the Clutha river in New Zealand in 1865. The earliest bucket-dredge in the United States was erected near Bannack, Montana. The Alder Gulch and the Ruby districts have produced many millions in gold.

In 1898 the Conrey Placer Mining Co. was formed, to

places: first 16 tables, 85.32%; last 8 tables, 2.6%; tail-slucies, 8.94%; undercurrent, 0.55%; and well, 2.59%. The bullion from the four boats varies from 822 to 873 fine.

Many improvements in dredging have been started in the Ruby district, including the mooring-head or aerial-spud, large buckets, one-piece manganese buckets, manganese baffle-plates in the revolving-screen, 2200-volt motors, and the direct gear-connected motors for the bucket-drive. The technical operations of the Conrey commenced in the earliest days of gold-dredging in this country. The company tested steam against electric dredges, and the sluice-dredge against the stacker type.

Costs in 1915 totaled 5.99c. per yard, there being



SECTIONS OF WASHING-SCREEN, NO. 4 CONREY DREDGE.

exploit a gravel deposit at Ruby, $1\frac{1}{2}$ miles from Alder, and 80 miles from Butte. Since 1899 the company has dug over 37,000,000 cu. yd., yielding 16c. per yard. This represents 80% of the dredging done in Montana. Seven boats were operated, but at present there are four, details of which are given in the table appended.

No. 4 dredge was designed to dig large quantities of ground of low value to a depth of 55 ft. below water-level. Its best record month was in May 1915, when 411,000 cu. yd. was dredged in 82% running time, at a depth of 54 ft., and at a cost of 2.66c. per yard. The buckets hold 16 cu. ft., and weigh 5200 lb. each. The digging motor is of 550 hp., while the total motor rating is 1285 hp. Pumps are of 16 and 14-in. size, and raise 12,000 gal. water per minute. The accompanying sketch shows the washing-screen, which is 50 ft. long and 8 $\frac{3}{4}$ ft. in diameter. It weighs 110 tons, and is probably the heaviest trommel used in gold-dredging. The spuds weigh 44 tons each.

The four dredges cost \$955,000. In all, there are 85 men employed, 36 actually on the boats.

The gold recovered on No. 4 is saved in the following

3,632,677 cu. yd. dredged. Items were as follows: labor, 1.13; fuel, 0.06; power, 1.15; supplies, 0.08; upkeep of chain, 0.98; repairs, 1.65; indirect charges, 0.94; a total of 5.99 cents.

The gravel at Alder Gulch and Ruby is not so hard and compact as that at Oroville and Natoma in California, but is more difficult than that of the Yuba river, though not so deep. Large boulders are found embedded in clay. The bedrock is favorable. The winter temperature of 25 to 30°F. below zero is a great handicap, but this has been successfully overcome. Wages per 8-hr. shifts are higher than in California.

Outside of the Grasshopper and Alder Gulch districts little gold dredging has been done in Montana. Attempts made in other places met with little success. A 5-cu. ft. boat on Cold creek worked part of two seasons in 1905. About 19 miles from Helena the Magpie company operated in 1910. In the same year the Kansas City Commercial Co. started a 7 $\frac{1}{2}$ -ft. boat 10 miles from Iron Mountain; it has run intermittently since. Three other dredges were built by various concerns, but only worked a few weeks.

CONSTRUCTION DETAILS OF THE CONREY PLACER MINING CO.'S FOUR DREDGES AT RUBY, MONTANA

	No. 1	No. 2	No. 3	No. 4
Power used	Electricity	Electricity	Electricity	Electricity
Date built	1908	1908	1906	1911
Type	Single-lift table	Single-lift table	Single-lift table	Single-lift table
Stacker	Spud	Spud	Spud	Spud
Average monthly yardage	96,270	62,709	82,115	300,000
Hull dimensions:				
Draught	5 ft.	5 ft. 6 in.	6 ft.	9 ft.
Length	96 ft.	140 ft.	130 ft.	150 ft.
Width	44 ft.	44 ft.	48 ft.	58 ft.
Depth	9 ft.	9 ft.	7 ft. 11 in.	13 ft.
Pontoon dimensions:				
Length	None	None	50 ft.	None
Width	None	None	40 ft.	None
Depth	None	None	3 ft. 11 in.	None
Stacker dimensions:				
Length	96 ft.	85 ft.	None	130 ft.
Width of belt	34 in.	34 in.	None	4 ft.
Motor drive				
Tailing height	Upper end 30 ft.	Upper end 30 ft.	None	Upper end 55 ft.
Dimensions of steel spuds:				
Length	48 ft.	54 ft.	None	80 ft.
Width	3 ft.	3 ft.	None	4½ ft.
Thickness	2 ft.	2 ft.	None	3 ft.
Weight	26,500 lb.	29,000 lb.	None	88,000 lb.
Number	1	1	None	2
Dimensions of wooden spuds:				
Length	48 ft.	54 ft.	None	None
Width	3 ft.	3 ft.	None	None
Thickness	2 ft.	2 ft.	None	None
Number	1	1	None	None
Horse-power:				
Bucket-chain	100	100	150	550
Trommel	20	20	10	100
Pumps	160	169	175	285
Winches	20	20	115	250
Miscellaneous	70	70	10	50
Total horse-power	380	380	460	1,235
Ladder data:				
Length	68 ft.	80 ft.	100½ ft. ¹	116 ft.
Type	Lattice-girder	Lattice-girder	Lattice-girder	Plate-girder
Depth digging below water	20 ft.	35 ft.	45 ft.	55 ft.
Dimensions of tumblers:				
Upper tumbler:				
Distance above deck	25 ft. 9 in.	29 ft. 3 in.	31 ft.	35 ft. 6 in.
Weight	5,970 lb.	8,970 lb.	8,970 lb.	16,000 to 25,300 lb.
Number of sides	6	6	6	6
Shaft diameter	16 in.	16 in.	16 in.	25 in.
Lower tumbler:				
Weight	5,800 lb.	5,800 lb.	5,500 lb.	18,000 to 19,800 lb.
Number of sides	6 to round	6 to round	6 to round	6 to round
Shaft diameter	13¼ in.	13¼ in.	13¼ in.	15¾ in.
Bucket-chain data:				
Type	Close-connected	Close-connected	Open-link, later changed to close-connected	Close-connected
Drive	Belt	Belt	Gear	Gear
Weight	169,000 lb.	225,000 lb.	297,000 lb.	357,500 to 415,300 lb.
Capacity of buckets	7½ cu. ft.	7½ cu. ft.	13 cu. ft. open, 9½ closed	16 to 17 cu. ft.
Number in chain	60	80	13 open, 80 closed	80
Weight	2,504 lb.	2,504 lb.	2,000 lb.	4,468 to 191 lb.
Pitch	32¾ in.	32¾ in.	22¾ in.	40 in.
Buckets dumped per minute	16	15	15	18 to 22
Type	3-web	2-web	2-web	2-web
Material	(2)	(3)	(2)	(2)
Hook and base, No. pieces	2	(3)	(2)	1
Links:				
Weight	None	None	1,250 lb.	None
Pitch	None	None	32¾ in.	None
Number in chain	None	None	43	None
Material	None	None	Steel	None
Type	None	None	3-web	None
Pins:				
Diameter	1½ in.	5 in.	5 in.	7 to 8 in.
Weight	168 lb.	184 lb.	184 lb.	520 to 495 lb.
Material	Steel	(2)	(2)	(2)
Type	Single lug	Single lug.	(4)	Single lug.
Pin bushings:				
Type	Full circle	Full circle	Full circle	Full circle
Material	Manganese	Manganese	Manganese	Manganese
Trommel data:				
Length	75 ft.	25 ft.	18 ft.	48 ft. 6 in.
Diameter	51 to 72 in.	51 to 72 in.	61 in.	98 in.
Type	Stepped cylinder	Stepped cylinder	Straight cylinder	Straight cylinder
Drive	Belt	Belt	Belt	(2)
Plates:				
Thickness	¾ in.	¾ in.	¾ in.	1 in.
Material	(2)	(2)	(2)	(2)
Perforations of plates:	½ to ¾ in.	½ to ¾ in.	½ by 6 in.	½ to ¾ in.
Dimensions of tables:				
Grade	12½%	12½%	12%	12½%
Number	20	20	10	21
Width	20 in.	20 in.	20 in.	20 in.
Length	15 ft.	18 ft.	12 ft.	11 to 23½ ft.
Ribbs (angles)	1½ in.	1½ in.	1½ in.	1½ in.
Perforated plates			¾-in. hole	
Pump data:				
Number	4	4	5	3
Size and kind	3-in. water	3-in. water	3-in. water	4-in. water
	8-in. water	8-in. water	Two 10-in. water	11-in. water
	12-in. water	12-in. water	11-in. water	16-in. water
	6-in. sand	6-in. sand		
Make	Morris	Morris	Morris-Worthington	Worthington
Gallons per minute	6,700	6,700	12,500	12,000
Main wind data:				
Length	20 ft. 1 in.	20 ft. 1 in.	11 ft. 10 in.	29 ft. 10 in.

changed to 116 feet.

Steel; later changed to manganese.

Steel buckets in two pieces; manganese in one.

Lock pin; later changed to single lug.

Gear; later changed to belt.

	No. 1	No. 2	No. 3	No. 4
Width	4 ft. 11 in.	4 ft. 11 in.	8 ft. 6 in.	7 ft. 5 in.
Diameter of drums	16 in.	16 in.	30 in.	24 in.
Number of drums	8	8	2	8
Tail sluices:				
Grade	12 1/2%	12 1/2%	None	12 1/2%
Number	2	2	None	12
Length	40 ft.	40 ft.	None	17 to 44 ft.
Width	48 in.	48 in.	None	18 in.
Riffling (angles)	1 1/4 in.	1 1/4 in.	None	1 1/4 in.
Undercurrents:				
Grade	None	None	10%	12 1/2%
Number	None	None	2	12
Length	None	None	54 ft.	7 1/2 ft.
Width	None	None	13 in.	34 in.
Riffling:				
Material	None	None	Wood	Angles
Size	None	None	1 by 1 1/2 in.	1 1/4 in.
Perforated plates:				
Width of slots			1/16 in.	1/4 in.*
Well save-all:				
Grade	8%	8%	8%	8%
Number	1	1	1	1
Length	7 1/2 ft.	7 1/2 ft.	25 5/8 ft.	18 1/2 ft.
Width	18 in.	18 in.	18 in.	18 in.
Upper flume:				
Grade	None	None	6%	None
Riffling:				
Material	None	None	Angles	None
Size	None	None	2 by 2 1/2 in.	None
Length	None	None	28 ft. 10 in.	None
Width	None	None	62 in.	None
Lower flume:				
Grade	None	None	6%	None
Riffling:				
Material	None	None	Angles	None
Size	None	None	2 by 2 1/2 in.	None
Length	None	None	135 ft.	None
Width	None	None	66 in.	None
Total gold-saving area	1,231 sq. ft.	1,231 sq. ft.	1,261 sq. ft.	2,000 sq. ft.

*Holes instead of slots.

A New Flotation Oil

As mentioned in the PRESS of August 12, sage-brush will probably supply oil for flotation purposes. For the Arizona meeting of the American Institute of Mining Engineers, Maxwell Adams of Reno prepared a short paper on the subject.

During 1915, a study of the essential oil in desert plants was begun in the chemical laboratory of the University of Nevada. None of the oils so far studied possesses properties of special interest to engineers, except the oil of sage, *Artemisia tridentate*, which has exceptional power as a flotation agent. This plant, known as common sage-brush, also called black sage, is widely distributed over the semi-arid West.

The method of extracting the oil in the experiments was simple. The leaves, twigs, and small branches, are placed in an air-tight drum, having a capacity of 27 cu. ft. Steam is admitted through a number of small openings at the bottom of the retort, and the pressure maintained at 20 to 25 lb. per sq. in. for three hours. The escape of steam from the retort is regulated by allowing it to pass through a stop-cock into a condenser. The water in the receiver is drawn-off from time to time and the oil, which is insoluble and floats upon the water, is thus collected. At the end of two hours most of the oil has been driven out, though traces continue to come over for a much longer time. By raising the pressure, the time required could probably be shortened and the yield increased, but the lack of laboratory equipment prevented the carrying out of this experiment.

The stock-wood, bark, and branches contain no oil, the distribution of oil being limited to the leaves and young shoots. There is a seasonal variation in the amount of oil contained. Samples collected on different dates gave

the following amount of oil: May 1, 0.42%; May 27, 0.6; June 30, 0.72; August 1, 0.9; and September 10, 0.1%. The increase appears fairly constant from early spring, when the leaves first appear, until light frosts occur in the autumn. When the plant is air-dried there is some loss of oil, as the following will show: Two 100-lb. samples were collected at the same time; one was distilled when green, the other was air-dried for 10 days before distillation. The green sample yielded 275 grams, and the dried sample 248 grams of oil, showing a loss of about 10%.

The laboratory can give little data useful in forming an estimate of the commercial cost of production. A man working for six hours, using a pair of common pruning-shears, collected twigs which yielded one pound of oil. Since only a small quantity of the oil is lost if the brush is dried, the most economical method of production would perhaps be to collect it in large quantities, by using a tractor-engine and a drag, in some such way as land is cleared for farming. When the brush is dry, the leaves and young shoots are easily shaken from the limbs. Thus the amount of material to be distilled would be greatly diminished, and the oil obtained at a cost and in sufficient quantity to make it available as a flotation oil, if not alone, possibly as an ingredient, to increase the flotative power of other oils.

The crude oil is dark in color. When re-distilled with steam it is water-white at first, changing gradually to a straw-yellow color on standing. It has the following physical properties. Density at 15 C., 0.9206; refractive index at 20 C., 1.4732; rotation at 20 C., -4.69.

The chemical properties of the oil are as yet undetermined. The important question for the engineer is: Can the oil be produced in quantity and at a cost that will make it available for ore flotation?

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

CUPRO-DESCLOZITE is the vanadate of lead, zinc, and copper. It is a rare mineral found at Camp Signal in San Bernardino county, California.

A TON of Atlantic Ocean water, evaporated, yields 81 lb. of salt; while equal quantities from the Pacific Ocean and Great Salt Lake, Utah, gives 79 and 175 lb., respectively.

THE LATENT HEAT of fusion of gold is 163 calories. In the case of most metals the latent heat of fusion is about one-third the heat required to raise the metal from absolute zero, -273°C ., to its melting-point.

GOLD in ore of south-eastern Alaska, principally in the Juneau district, averaged \$1.79 per ton in 1915, and silver 1.5 cents, against \$2.43 and 0.8 cents in 1914, respectively. Nearly 3,000,000 tons was treated.

BURNING POWDERED COAL is the best method by which to obtain perfect combination of the air and coal, and by which the highest degree of perfection in combustion may be obtained. The greatest precision is required in its control in order to produce satisfactory results.

GLASSWARE for chemical purposes, equal to the famous Jena, Germany, product, is now being made in the United States, according to Allen Rogers, of the American Chemical Society. The domestic glass is to be exhibited at the Second National Exposition of Chemical Industries at New York on September 25. Many other American products will be on view, also moving pictures showing certain industries.

FIRES have been common in the United Verde copper mine for 22 years. The soft and highly pyritic (mostly chalcopyrite) nature of the ore is responsible for most of these outbreaks. The Plenum system of fighting the fires has been successful since 1905. Briefly, this consists of forcing air under pressure, 2 to 5 lb. per sq. in., into the fire area. The air pressure varies with the gas pressure, and must be sufficient to keep back the gas and to cool the ground, so that work can be done.

COPPER RELICS of a pre-historic age have been discovered in a mine of the Cottonwood district near Salt Lake City. Besides copper, iron, and flint tools, a marble tablet decorated with crude drawings and hieroglyphics apparently of Indian origin has been found. Native copper ore exists in the rocks near-by, suggesting the source of the copper in the tools. The exact location has been kept secret. Many interpretations have been devised to account for the drawings and hieroglyphics on the marble tablet; one story concerns a black-eyed Indian

princess called No-ni-shee, 'the maid who put the salt in Great Salt Lake' by her weeping. As is well known, the Emma, an old copper mine in the Cottonwoods is being re-opened, and not far away are the great copper mines of Bingham Canyon.

NOT MORE THAN 30% of the timber in the forests of the United States is ever utilized as lumber, according to figures recently compiled by the office of Industrial Investigations of the Forest Service. Seventy per cent, chiefly in tops, limbs, stumps, bark, saw-dust, slabs, and small and defective trees, is for the most part wasted. Of the wood in the individual tree, 33.5% is made into lumber, and of the logs that reach the mill 40.3% is worked up into lumber. How this waste occurs is well illustrated in the saw-kerr or saw-dust, which averages 13% of the log. This means that for every seven one-inch boards sawed from a log, one board is wasted in saw-dust.

GUN-COTTON was discovered by Schonbein at nearly the same period that nitro-glycerine was discovered by Sobrero. Trials were made in 1846 by the French war department to utilize gun-cotton, but though chemists like Pelouze worked for years, an unfavorable report was made, as too many spontaneous explosions ensued. Later in Austria, a careful investigation after improvements by Baron von Lenk indicated the practicability of using gun-cotton for fire-arms as well as blasting. Schonbein's discovery indicated that when cotton-wool is steeped in a mixture of strong sulphuric and nitric acids, a transformation into gun-cotton takes place almost without change in appearance. Gun-cotton is not so powerful nor so cheap as nitro-glycerine and is therefore not so much used in mining, but has the advantage of not freezing. Blasting gelatine, an important modern explosive, is made by dissolving gun-cotton in nitro-glycerine.

DYNAMITE of the variety known as 'straight dynamite' and of the strength known as 40% contains 40% of nitro-glycerine, 44% of sodium nitrate (which is the principal ingredient of black powder), 15% of wood pulp, and 1% of calcium or magnesium carbonate. A typical 60% dynamite contains 60% nitro-glycerine, 23% of sodium nitrate, 16% of wood pulp, and 1% of calcium or magnesium carbonate. Low-freezing dynamite or the ammonia dynamites are not so powerful in action as straight dynamite. A low-freezing dynamite of 50% strength contains only 38% of nitro-glycerine, the other 12% being a nitro-substitution compound. Ammonia dynamite absorbs water readily, which is a disadvantage. A 50% ammonia dynamite contains only 27% of nitro-glycerine, with 25% of ammonium nitrate, and 36% of sodium nitrate. A gelatine dynamite of 50% strength contains 42% of nitro-glycerine, 1.5% of nitro-cellulose, and 45% of sodium nitrate. The gelatine formed by the addition of nitro-cellulose to nitro-glycerine is impervious to water, and this explosive is adapted for wet blasting.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

ANOTHER DRAINAGE SCHEME.—ANOTHER DREDGE TO BE BUILT.—

ALLEGHENY, PROGRESSIVE, AND GARBUTT IMPROVEMENTS.

Drainage of the entire Leadville district to a considerable depth is now practically assured. The Down Town section has been unwatered through the Penrose shaft to a depth of 978 ft.; Fryer hill and the Big Evans basin have been drained through the Harvard shaft to a depth of 800 ft., and sinking of the shaft is about to be started; the Mikado shaft on Iron hill is being prepared for unwatering that immense area to a depth of 1100 ft.; and another large unwatering enterprise has been launched for draining part of California gulch and Rock hill through the La Plata.

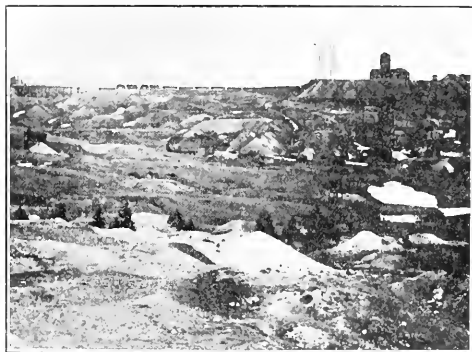
Still another drainage project is being perfected to operate through the Wolfstone shaft, where the Empire Zinc Co. and Western Mining Co. recently completed unwatering to the 1000-ft. level, and through the Greenback shaft adjoining. Layne-Bowler electrical deep-well pumps have been installed in both properties under the direction of W. E. Jones of Los Angeles. The pumps in both shafts will be lowered together early in the week, and pumping will be continued until the water-level has been forced below the Wolfstone shaft-bottom, at a depth of 1320 ft. The sinking-pumps will be connected with large station-plants of steam machinery that are installed at 1000 ft. in the Wolfstone and at 900 ft. in the Greenback. These relief pumps will throw the water to the surface. The two plants will pump 2500 gal. per minute. The Wolfstone-Greenback scheme is regarded as being the most important pumping project that has yet been undertaken in the district, because it will open to mining a more extensive area of rich territory and at greater depth than any previous unwatering has done. Together with the Mikado, which is expected to be pumping within the next three months, the Greenback and Wolfstone will form the strongest combination in the district. When these enterprises are completed, the district will be drained from Rock hill on the south to Prospect mountain on the north, and from the Down Town section on the west to Adelaide park on the east, a territory about 16 miles square.

The second dredging company to enter the Leadville district is now being formed by John R. Champion, former superintendent of the Yak Mining, Milling & Tunnel Co., who has secured control of a large tract of placer ground in the mouth of Iowa gulch. For several weeks he has been prospecting this area with shafts from 10 to 15 ft. deep, yielding from 45c. to \$1.50 per cu. yd. so far. These results are regarded as ample justification for the installation of a dredge. At present the water problem is delaying progress, as it will be difficult to secure enough to float the boat, especially when it begins to advance up the gulch. This obstacle will, however, be overcome as the gold-content is too high to be discarded. Operations may not be undertaken until next spring, but not later.

A long term lease has been secured by W. E. Bowden on the Allegheny mine on Yankee hill, in the centre of one of the richest, and at present, most active sections of the district. The property is surrounded by the Mikado, Robert Emmet, McCormick, and El Paso, and directly in line with the great ore-shoots that have been developed through these and other nearby properties. At present work at the Allegheny is confined to re-timbering the shaft, which is 700 ft.

deep. A steam plant has been installed at the shaft, but as soon as the re-timbering is finished, a modern electric plant will be put in. The sinking of the shaft several hundred feet will follow, as it is proposed to cut the Ponsardin ore-shoot, which dips under the Allegheny to the north-east.

In charge of Warren F. Page, the old Progressive mine on Fryer hill has been re-opened and the shaft is being re-timbered. A new electric surface plant has been installed, and work is being done as rapidly as possible. The Progressive was one of the bonanzas of the early days, when Fryer hill was the scene of the greatest excitement in the history of the district. At that time the mine was a consistent producer of high-grade silver ore. Ten years ago it was operated by lessees, who also extracted some similar grade ore, but the closing of other mines adjoining, which were then pumping,



GREENBACK SHAFT AT LEFT, WOLFSTONE AT RIGHT; NEW DRAINAGE SCHEME AT LEADVILLE.

drowned the high-grade stopes. Since then no work has been done, and undoubtedly it would still be idle but for the draining of Fryer hill through the Harvard shaft, an undertaking just completed by the United States Smelting, Refining & Exploration Company. An extensive campaign of development has been planned by Mr. Page for the re-opening of the rich stopes supposed to be uncovered in the bottom levels.

The manager of the Garbutt mine, John Cortellini, is now completing plans for the construction of a 250-ton mill for concentrating the gold-bearing ore that is being extracted from the Garbutt and Ilex No. 3 shaft adjoining, and which is under lease to Cortellini and his partners. The orebody, which is an immense porphyry cap, is the largest now open in the district. The daily output is 250 tons, and it is stated that the ore will average \$20 per ton. Production is now shipped directly to smelters, and is subjected to a heavy treatment charge that would be saved if the ore were concentrated before shipping. It is estimated that the plant proposed for the Garbutt will cost between \$60,000 and \$70,000. At the present rate of production, this amount would be realized on reduced costs in one month. A small but continuous fissure of rich gold-copper ore has been opened recently in the Garbutt, and is now being developed through 10 levels. The vein averages 3 ft. in width, from which 50 tons per day is being extracted.

BUTTE, MONTANA

BUTTE & BACORN AFFAIRS.—SLAG TREATMENT.

The re-organization of the Butte & Bacorn has put the property under the control of the newly formed Great Butte Copper Co. The failure of the Butte & Bacorn's fiscal agents in 1907 left the company \$14,000 in debt. This, with the cost of maintaining the property, of perfecting title to unpatented claims, of taxes and litigation, has resulted in a debt of \$50,000 and interest. The indebtedness is secured by a mortgage that has been overdue since 1912. Foreclosure proceedings were commenced some time ago, and a re-organization of the company would have been effected through the courts if the shareholders had not been successful in their efforts to re-organize it. The new company has a capital of \$1,000,000. The shares have a par value of \$1; 200,000 of them are in the treasury. All of the property of the Butte & Bacorn was sold to the new company for 400,000 shares, or one-half of the stock which is to be issued. This gave holders one share of new stock for each 10 shares of Butte & Bacorn stock. The remaining 400,000 shares were sold at 66c. per share, and the fund so realized amounts to \$264,000. The plan had the same effect as though each holder had given up half of his stock to be sold for the benefit of the enterprise. Out of this fund the old company's debts will be paid. The Calumet shaft has been bought back for \$19,000. It was sunk to a depth of 1000 ft. just outside of the company's line, but on ground which was held under option at that time. For this \$19,000 the company will get only the shaft and such surface as is necessary, but it will hold an option on the mineral rights of the three adjoining claims on the same terms that the Butte & Bacorn had in 1907. The company will have \$180,000 available for continuing development. The shaft will be pumped out and repaired, and some driving and cross-cutting done on the 1000-ft. level. Sinking of the shaft to the 1500-ft. level will be started, and the company has enough money to drive 5000 ft. of drifts and cross-cuts at that depth. Several large veins outcrop on the company's ground, and good copper ore has been shipped from one of them. The property is one mile north of the Butte & Superior. It is presumed that the veins have been leached of most of their mineral content from the surface to the 700-ft. level; below that level either copper or zinc may be found. The copper-bearing veins of the Butte district contain iron oxide at the surface, while the outcrops of the silver-zinc veins consist mainly of quartz, stained with manganese oxide. The surface conditions indicate that the veins will be copper bearing at depth, and as the management is capable and efficient the Great Butte Copper Co.'s chances of becoming a copper producer are considered good.

The high price of copper makes it possible to ship some of the slag dumps accumulated at the old smelters near Butte. The slag that contains the most metal is usually in the lower parts of the dumps. This is the slag that was made when the smelters were first blown-in, and after covered to a depth of 20 ft. with slag that is too low in copper to be profitably worked. The lower stratum is being mined and the overburden held in place by timbering. The tailing dumps from the old concentrators have been worked for years. The acid mine-water is used to leach them and the copper precipitated on scrap iron. In some cases tailing was covered with slag, and in places where the slag is not too deep it is being removed and the tailing that seems to be worth more than the average is shipped to a smelter. The slag is useful as an ingredient in concrete, and about 100 tons per day is used for that purpose. Granulated slag from the Anaconda smelter has been tried as ballast, but it does not pack well and is not generally considered satisfactory for that purpose.

Two electric motors, a tube-mill, beister tables, and other machinery have arrived at the Ophir mill for the Butte-Detroit company. A flotation plant may be erected to treat the zinc-silver ore. The shaft is completed to 980 feet.

JOHANNESBURG, TRANSVAAL

CINDERELLA CONSOLIDATED AFFAIRS.—FAR EAST RAND.—SUNDAY WORK AT THE MINES.

The optimism of the mining financier is an asset to the Rand. The chairman of the Cinderella Consolidated assures the shareholders that fresh funds to re-start the mine will be found, and there is little doubt he will manage it. Already £1,250,000 has been spent on the mine. The net result being that after a lengthy but hand-to-mouth existence as a producer, the mine was closed-down, because it failed to pay operating costs, let alone debenture interest and redemption. However, George Denny has made a report on the mine, and shareholders—poor beggars—have been regaled with crumbs from the rich man's table, the said crumbs being assorted fragments from what is believed to be a very bulky document. According to the chairman, Mr. Denny reports most favorably on the future prospects of the mine. The reasons given for the former failure being:

(1) Insufficient working capital to develop the mine properly.

(2) Mistakes in mining, the management leaving the most profitable portion of the orebody in the foot or hanging wall, I forget which.

Mr. Denny may be quite right and bad mining may be the real reason for the mine not paying. Have the shareholders any right to grumble at the past management? Certainly not says the cheerful chairman; he assures them that the mine was most capably and carefully managed, but it required a special genius to find the hidden treasure. This having now been found all will be well. After reading Mr. Denny's report, according to the cheerful chairman, mining on the Cinderella Con. will be made quite easy and under the same three Cs management as in the past the right and not the wrong orebody will now be worked.

A lot yet remains to be done on some of the mines, especially the 'deep-levels' of the Far East Rand, to make them reasonably healthy. A man I know well was out of a billet and secured a shift-boss's job on one of the most highly boomed and advertised mines in that district. The pay was £40 per month, free house, water, lights, coal, etc. He stayed just three days and left of his own accord, saying that he would not stay if they gave him £60 and fed him. Smoke and dust simply awful, phthisis in six months, is his verdict, and he is by no means a particular person, and is an old hand at mining. He is now working for less money on an outcrop mine, where proper attention is paid to health. On the deeper 'deeps' this sort of thing seems common.

I am sending you a copy of the State Mining Engineer's report on the Far East Rand. The Government has not yet accepted any tenders, and report says that the American syndicate did little or no business. A great many amiable people are insisting that all the wonderful millions guessed at by the Government engineer must be kept in the country and none of it wasted in paying dividends to overseas shareholders. The only way, according to these enthusiasts, is for the Government to develop and mine the areas, and keep all the profits for the good of South Africa. It is a great pity that the Government is frightened to take a bold line and let the leases to responsible people and get the work going. Of course, they, the members of the Government, are suffering from a failing common to some of their ancestors "of asking too much and giving too little," and they are a bit spoiled by the wonderful terms they got for leasing the Modder areas. But the personal element entered very largely into the last deal. Everybody supposed to be interested had been consulted and it was arranged that the Mines Selection Company should be the only tenderer, but the Corner House and their associates had forgotten to consult Barnato Bros., who at the last moment put in a more favorable offer, and obtained the lease. This sort of thing is not likely to be repeated. The

least speculative areas are probably Brakpan 16 and Springs 15 and the bit of Geduld adjoining the Geduld mines and Springs 15. Outside of this area the ground is very speculative, and it is absurd of the Government to hang up the exploration and development of the district by being so greedy. It would be a great deal more to the advantage of South Africa if they gave fairly generous terms to the enterprising firms that having done well in the past are prepared again to take chances, but in return for really good terms it should be a *sine qua non* that every possible precaution should be insisted to lessen the dust and smoke which in most of the 'deeps' is a crying scandal.

Your correspondent's remarks on Sunday labor in your number of June 24 seemed like very ancient history to us over here, the ridiculous idea that mining should be kept going every day of the week has long ago been abandoned, and it seemed funny to read that such ideas should persist on your side. For our local conditions, however, we have not to thank any particular virtue of our own or any excess of brain-power, but simply that long ago the Government made strict regulations, and any manager who broke them would soon lose his ticket and his job. The only way Mr. Brown will get the matter reformed is, I think, by the strong hand of the law, although I admire his faith in human nature in thinking it possible without compulsion to knock sense into shareholders and directors. Experience has taught us here that eight hours underground and no Sunday work, also compulsory holidays away from the mines, are really aids to economic working, but we should never have had a chance to learn this if the law had not compelled us to do so.

PLATTEVILLE, WISCONSIN

SITUATION IN THE ZINC REGION DURING AUGUST.

During August operating companies struggled against lower offerings for zinc ore and high costs of supplies and labor, but maintained working schedules without interruption at all points in the field, production and shipments comparing favorably with periods of higher prices.

The month opened with 60% zinc concentrate and premium grades on a basis of \$60 per ton. This price was shaded to \$50 per ton on second and medium-grade ore. Products assaying 40 to 50% zinc-content, offered by independent companies, were in fair demand part of the month, and some found its way into the bins of the zinc-ore refineries offering a market. Most of the ore that tended to help continue nearly normal production came from the groups of mines operating in combination with zinc-ore refineries or the smelter companies. A careful estimate of surplus on August 26 showed over 5000 tons. This is held entirely by small independents who can ill afford under present conditions to hold such a dead investment. No talk of a shut-down has been heard anywhere in the field, and new companies just completing and equipping mines are going ahead undismayed at the rather discouraging conditions that confront them. Leading mine managers declared that it is less profitable mining and selling ore on present offerings than it was two years ago, when jack sold at \$10 per ton, 60% basis. Prices for mining supplies have increased from 30 to 40%, and labor is high, machine-men being paid from \$3.50 to \$4 per shift; miners \$3; mill-men, \$25 per week; muckers, 16c. per ton; trammers, \$2.75 per shift; engineers, \$100 to \$125 per month; underground bosses, \$100 per month; and cartage 25c. per ton-mile. At the same time the managers consider that it is impossible to lower wages, as men of all classes are in great demand throughout the region. It is predicted that a change for the better must come soon, otherwise many zinc mines will be compelled to suspend operations. There does not appear any combination of circumstances that invite a change, and while the field is making the best showing in its history, there is a feeling of suppressed discouragement. Many concerns that have earned enviable

reputations as dividend-payers with lower markets have declared no distribution of profits for several months.

The marketing of pyrite was nominal. Production is bound to continue without abatement, as this is impossible in the Wisconsin field, where nearly all of this is secured as by-product at the zinc-ore refineries. Such sales as were made came from one or two refineries that have been discreet enough to secure contract arrangements. One of the largest refineries here submitted a statement near the end of the month that there is held in the field at all plants more than 15,000 tons of iron pyrite, all fine secured from separation of zinc ore.

Shippers of carbonate of zinc ore experienced another dull month, prices apparently being good but the demand indifferent. The Hard Fibre Co. of Delaware entered as a new buyer. Deliveries of ore during August, up to and including the 26th, were as follows:

Districts	Zinc pounds	Lead pounds	Pyrite pounds
Benton	18,662,000	564,600	90,000
Galena	5,808,000	.....	.....
Milfin	4,144,000	.....	.....
Cuba	3,928,000	60,000	2,169,600
Linden	3,504,000	77,970	160,000
Hazel Green	2,940,000	.....	.....
Shullsburg	2,352,000	30,000	.....
Platteville	2,216,000	.....	.....
Highland	850,000	.....	.....
Montfort	342,000	.....	.....
Mineral Point	228,000	.....	728,000
Potosi	70,000	.....	.....
Total	45,054,000	732,570	3,138,600

The gross yield of crude ore from all mines for the field exceeded 17,500 tons; several mines that had accumulated large stocks of concentrate unloaded this surplus, which at the beginning of the month stood at nearly 10,000 tons. Net deliveries out of the field, nearly all high-grade refinery product, totaled 9500 tons.

SUTTER CREEK, CALIFORNIA

CENTRAL EUREKA MINE.—ARGONAUT MILL.

Delay in the arrival of power drills is given as the reason for deferring the proposed sinking of the Central Eureka shaft. The sump has been cleaned-out, and the shaft-timbers put in good shape for sinking for one or more new levels below 200 ft. The orebody now yielding good ore on the present lowest level gives indication of persistence, and a comparatively short cross-cut from the shaft should reach this ore after the shaft is deepened. Twenty stamps of the Central Eureka 40 are in operation. V. S. Walsh of San Francisco, the president of the company, has been in Sutter Creek during the week, conferring with superintendent Fred Jost.

It is now expected that the beginning of the year will see crushing started at the new Argonaut mill at Jackson. The batteries are now being erected, the idea being to complete the installation of the extra 20 stamps with which this mill is to be equipped, before beginning the removal of the present 40 to their new place, and by moving 20 at a time, there need be no cessation in the operation of at least 40 stamps while the change is being made, a portion of the ore going to supply batteries at each mill while the change is in progress. Cars on a steep inclined track will be used to convey the ore from the bins at the shaft to those at the new mill 800 ft. west, and this will be so arranged that one employee stationed near the shaft can regulate the cars going to the mill and returning, as well as the division of ore for the different batteries. A number of improvements will be incorporated in this mill. Flooring has yet to be laid and concentrating machinery has not yet been installed, it being deemed expedient to do this after everything else is complete.

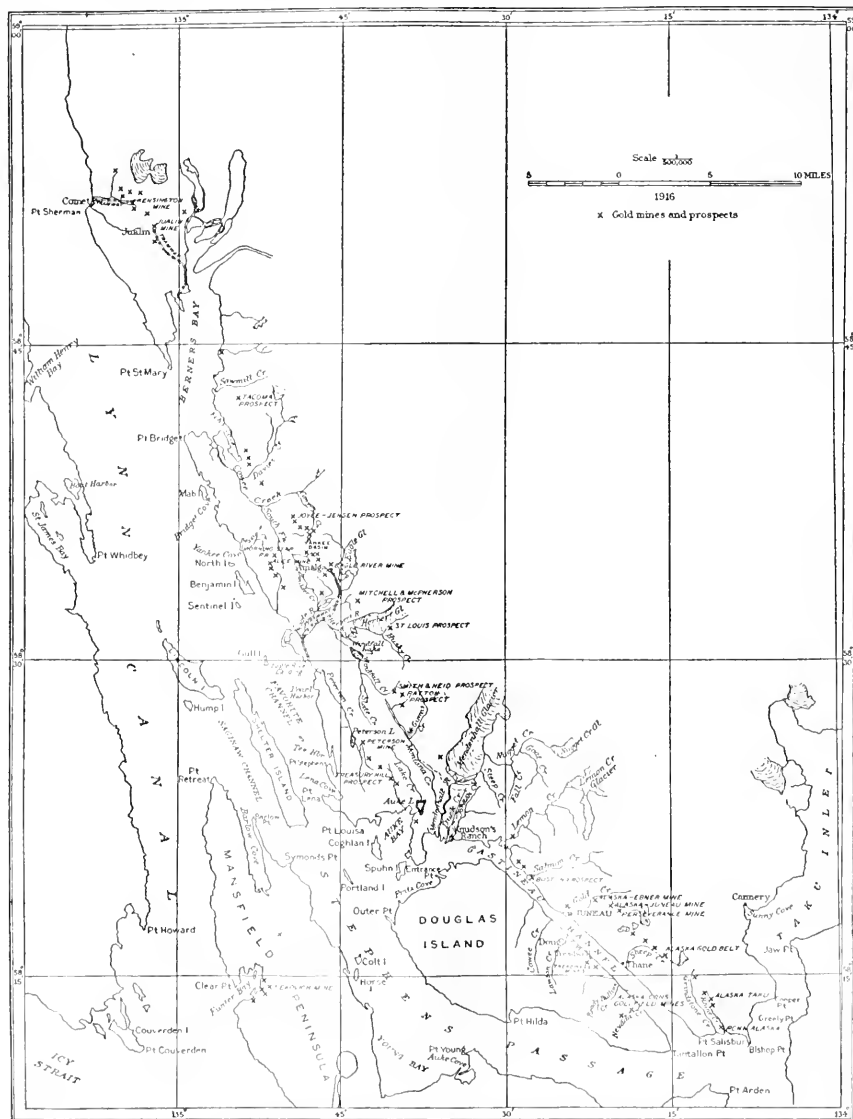
THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

Mining developments and water-power investigations in south-eastern Alaska are described in Bulletin 642-B of the U. S. Geological Survey by Theodore Chapin and George H.

Canfield. Some useful maps are included. Progress at the gold and copper mines of the Juneau, Wrangell, Ketchikan, Prince of Wales, and other islands is detailed. The value of the mineral output in 1915 was \$5,435,586 of gold, \$302,431 of copper, and \$352,554 of silver, marble, lead, and other. The



MAP OF THE NORTHERN PART OF THE JUNEAU GOLD BELT.

Juneau district produced most of the gold, which amounted to \$5,353,255 from 2,989,730 tons of ore, compared with \$4,157,191 from 1,712,530 tons in 1914. The Kasaan peninsula was the centre of copper mining in the south-east. From 50,406 tons of ore the yield was 1,728,182 lb. of copper, also \$33,000 of gold and silver. The streams of the Territory are important factors in its growth.

In Bulletin 642 of the U. S. Geological Survey is a report on progress of investigations during 1915 into the mineral resources of the Territory, by Alfred H. Brooks and others. As we have abstracted freely from advance chapters there is no need to give this useful publication further mention.

JUNEAU. During the first 10 days of September the Alaska Gold Mines reports that the average grade was \$1.51 per ton, an increase of 9c. per ton over August. There was treated in the period 50,150 tons, equal to 5000 tons daily, also an increase.

ARIZONA

BISBEE. On the 20th the American Institute of Mining Engineers met at Bisbee. E. C. Harder discussed the manganese situation. He said that the situation in the United States at the present time regarding the supply of manganese ores and alloys of manganese is one of great seriousness, and is likely to become increasingly so while the War continues. The dependence of America on foreign countries for this supply is being forcibly indicated. Other papers dealt with the exhaustion of oil and gas in the United States, geology of the Warren district, co-operative effort in mining, and gold and silver deposits in North and South America.

DOUGLAS. The first of the technical sessions of the convention of the American Institute of Mining Engineers, which is meeting in Arizona this week, were held on September 19 on the general subjects of smelting and leaching. Before the opening of these sessions the several hundred attending members, who are traveling through the State by special train, visited the reduction works of the Copper Queen Consolidated and of Calumet & Arizona Co. A. G. McGregor, of Warren, in an address on the 'New Copper Smelting Plants in Arizona,' told the engineers that in Arizona during the past five years there has been more activity in copper-smelting plant construction than in the same length of time in the history of the world. Mr. McGregor said that in this period five new copper-smelters had been constructed and put in operation. The monthly output from these plants, he said, averages from 5,000,000 to 18,000,000 lb. He then described new problems that had been met successfully and new features in plant design and equipment which had been developed. At the evening session on leaching, Frederick Laist and Harold W. Aldrich described the 2000-ton leaching plant at Anaconda, Montana. A paper on 'Possibilities in the Wet Treatment of Copper Concentrates' was read by Lawrence Addicks, and 'Leaching Tests at New Cornelia' were discussed by H. W. Morse and H. A. Tobbelmann. In the course of the day's proceedings John C. Greenway welcomed the members to Arizona and L. D. Ricketts, president of the Institute, responded for the delegates. The party left for Bisbee where the next day's sessions were held. Mining and geology were the subjects to be taken up in the technical discussions.

GLOBE. On the 21st the American Institute of Mining Engineers met at Globe and mainly discussed flotation. The Old Dominion mine and works were inspected.

(Special Correspondence.)—The Gold Dust mill has started on custom ore, treating that from the Gold Dust, Gold Key, Big Jim, and Lexington mines. For a month the work will be largely experimental, trying the process of superintendent Brush. A centrifugal separator, using mercury, is part of the apparatus. The ore is reduced to *minus* 100-mesh before going to this machine.

The Big Jim mine has been the subject of rumors, and an

attempted bear raid on shares. The mine was then examined, resulting in shares rising to over \$1. Work continues at 500 ft. The general average of the mine ore is claimed to be \$20 per ton.

The Tom Reed output is now at the rate of \$125,000 per month.

Oatman, September 11.

ARKANSAS

YELLVILLE. According to J. H. Hand, August shipments of zinc ore amounted to 79 carloads. Stocks are estimated at 1500 tons. The Rush district supplied 34 cars.

CALIFORNIA

The wage situation along the Mother Lode is as follows:

On September 14 the following letter was sent to employees by Grass Valley companies:

"We have learned that some of our employees believe that they are entitled to larger compensation and are circulating a petition for higher wages, stating therein among other things, that they are not in favor of strikes, etc., but believe in presenting their matters to their employer by petition. While it is true that wages of copper miners have been increased on account of the high prices of copper, the same conditions do not prevail in gold mines where the production brings the same price and where the cost of supplies has increased. We will, however, commencing October 1, 1916, pay the miners \$3.25, and shovelers and car-men \$2.75 per day. The bonus system will be continued as heretofore until further notice. We thank you for your co-operation and goodwill of the past, which we hope will continue.

EMPIRE MINES	BRUNSWICK MINES
NORTH STAR MINES	SULTANA MINES
GOLDEN CENTER MINES	UNION HILL MINES
ALLISON RANCH MINES	POLAR STAR Mfg. Co."

The 1000 men employed in this district will receive about \$50,000 extra yearly. The increase is 25c. per day.

On September 15 the following letter was mailed from Jackson to mine operators and owners in Amador county:

"Pursuant to action taken by Local No. 135, Mine, Mill and Smelter-workers Union, of United Federation of Miners, we invite you to meet with this Union to discuss the matter of establishing a uniform wage scale for Amador county. The Union will meet you individually or collectively, preferring the latter. If any Operator or Owner does not communicate with us respecting this matter before Monday, September 18, 1916, it will be taken for granted that such operators or owners refuse to meet with us. Trusting this meeting will be agreed upon and a friendly understanding had, we remain most respectfully, Local No. 135, Mother Lode Mine, Mill and Smelter-workers' Union.

By JAMES GAMBIRG no. secretary."

An answer was requested by Monday, the 18th. The Keystone, Little Amador, and Old Eureka companies, which are paying 25c. daily more than the others are not included. The wage paid by the former is \$3.50 for miners and \$3 for car-men and muckers.

On the 15th representatives from nearly all mines in Amador county conferred on the question at Jackson.

(Telegraphic Correspondence.) Strike on today; every mine in Amador county is idle, except for pumping.

Sutter Creek, September 19.

The State Industrial Accident Commission reports that during 1915 there were 533 fatalities; 1264 permanent injuries, and 65,741 minor accidents in all industries. Total payments amounted to \$2,002,706, up to June 30, 1916, divided into compensation \$1,150,504, and medical payments \$852,203. There were 13,254 injuries out of the 67,538 that lasted 15 days and over. The death list is a decrease of 158 compared with the previous year.

ANGELS. Local and San Francisco men have organized the

Angels Deep Mining Co. to develop the Pioneer mine, near the Gold Cliff and Lindsay mines. The shaft is 100 ft. deep, and equipment is sufficient for 500 ft. J. C. Benson is in charge.

FORBESTOWN. Ore treatment problems seem to have been solved here by extensive tests made with flotation systems, according to M. J. Cooney.

GRASS VALLEY. The Union Hill Mining Co. held a meeting at San Francisco last week. F. W. McNear is president. H. E. Fluke of Pasadena, one of the largest shareholders, was re-elected a director. W. H. Hamilton was elected to the directorate in place of G. S. Johnson. E. L. Oliver is treasurer, and Errol MacBoyle general manager. Sufficient tungsten ore was extracted to pay operating charges, and there is 10 tons of it on hand. The main shaft is to be sunk 400 ft. deeper, and electric pumps are contemplated to reduce costs.

The Empire Mines Co. is surveying an electric tramway one mile in length to connect its Empire and Pennsylvania mines. A 35-lb. rail is to be used, also a 4-ton electric loco capable of hauling 30 tons of ore. The present 60-stamp mill and cyanide plant is to be increased to 100 head and extra treatment capacity. The two mines are to be connected, necessitating sinking the Pennsylvania from 2600 ft. to 4600 ft. The present output is 415 tons of ore daily.

PLYMOUTH. The Plymouth Consolidated reports as follows for August:

Ore milled, tons	10,600
Total value	\$57,585
Working expenses	25,280
Development charges	9,838
Surplus	22,467
Other expenditure	7,319

SAN BERNARDINO. A decision in the lawsuit over the Searles Lake potash deposit in San Bernardino county was given by the Superior Court of this county on September 14. The decision is in favor of the defendants, the American Trona Corporation and others, in an action to quiet title brought by R. Waymire and E. Thompson, respectively, the claim-jumpers. It is unlikely that there will be an appeal.

COLORADO

CRIPPLE CREEK. An examination of the Cresson mine by Louis S. Noble shows reserves on August 1 to be 201,388 tons of ore averaging \$31.10 per ton. The net profit in this is estimated at \$4,130,318, or \$20.51 per ton. August shipments were at the rate of 6300 tons per month. The 1203 stope yielded \$33.33 per ton.

During August there was 11,000 tons of \$5 ore moved from the old Economic dump on Squaw mountain. The Economic Dump Leasing Co. controls the material.

Lessees of the United Gold company shipped a total of 1700 tons of \$20 ore to the Golden Cycle mill in August. The mines are the Trail, Trachyte, W. P. H., Damon, and Viola.

LAKE CITY. To treat old stope-filling and ore dumps the Colorado Utah Mines Operating Co., owned by Salt Lake City people, is to install fine-grinding machinery. The present mill is treating 40 tons daily. The treatment includes table concentration and flotation, yielding copper-lead-silver-gold concentrate. G. E. Edwards is manager.

RICO. The Rico Wellington company is out of debt and has \$6000 cash on hand, also 27 cars of 4 to 16% copper ore in transit to smelters. Profits in future should be from \$15,000 to \$20,000 monthly.

SILVERTON. August was a record month for shipments, the total being 1196 tons of crude ore and 5830 tons of concentrate.

IDAHO

HAILEY. Early in October the new 300-ton mill at the North Star-Triumph, operated by the Federal Mining & Smelting Co., will be ready for work. The mine is opening well.

MILLAN. In an extension of No. 6 tunnel of the Morning

mine the Federal company has opened a new orebody, 20 ft. wide, carrying high zinc-content as a sulphide. This shoot was unexpected.

MURRAY. The O.-W. R. & N. Co. has awarded a contract for construction of its new Beaver Creek branch to Twoby Brothers, railway construction contractors of Spokane and Portland, Oregon, according to announcement made in Spokane by Robert Twoby. Work will begin as soon as crews can be recruited and machinery assembled. The contract price is said to be approximately \$200,000, and it is probable that the 10-mile line will be completed and ready to operate in the next six months. The new road will connect with the Murray branch of the O.-W. R. & N. at Idora spur, and will provide transportation facilities for the Consolidated Interstate-Callahan, Ray-Jefferson, Idora, Tuscumbia, Virginia, Sunset, Toughnut, Friend, and several other properties in the district.

PINE CREEK DISTRICT. In the Denver mine adit the ore-shoot has been opened for 140 ft. The last sample across 54 in. assayed 31% lead, 20% zinc, and 19 oz. silver per ton. A compressor is being installed. W. A. Beaudry is in charge.

KANSAS

PITTSBURG. There are over 600 smelter-men out of work in this centre. The American, Bruce, and Lanyon smelters are closed, while six of the eight furnaces of the Pittsburg company are down. The Joplin Ore and the new smelter at Weir are the only ones in full operation, and the former is also to suspend work.

MICHIGAN

Houghton. Ore shipped to mills during August was as under, in tons:

Franklin	23,400	Tamarack	33,525
Centennial	13,100	Mohawk	54,000
Allouez	41,100	Wolverine	28,500
Mass	32,700	Abmeek	106,300
Superior	16,900	Oseola	119,250
Hancock	18,500	Calumet & Hecla	275,600
LaSalle	10,900	Copper Range	111,300
		Isle Royale	77,700

These figures represent a normal output for most of the mines. Centennial is extracting more than usual. Allouez should make an increase in September. During the first half of the year White Pine has treated 600 tons of ore daily, its mill capacity being 800 to 1000 tons.

MISSOURI

JOPLIN. Last week there was a noticeable falling-off in zinc and lead concentrate sales. The 'turn-in' was 3238 tons of blende, 70 tons of calamine, and 862 tons of lead, averaging \$51, \$40, and \$65 per ton, respectively. The total value was \$235,059, and for 30 weeks, \$23,881,158.

At the D. C. & E. mine, near Webb City, a Layne & Bowler vertical centrifugal pump, an innovation for this region, is to be installed. Its capacity is 1700 gal. per minute.

MONTANA

In Bulletin 121 of the U. S. Bureau of Mines, the history and development of gold dredging in Montana is discussed by Hennen Jennings. A chapter on placer-mining methods and operating costs, by Charles Janin, is included. These were papers read at the second Pan-American Scientific Congress held at Washington, D. C., December 27, 1915, to January 8, 1916. The publication covers 63 pages, and has 30 illustrations. Montana is next to California in amount of gold recovered by dredging. The first successful bucket-lift dredge in the United States was erected on Grasshopper creek, Beaverhead county, Montana, near Bannack. Work done in Alder gulch and the Ruby district, in Madison county, is described, especially that of the Conrey Placer Mining Co. at the latter centre. Its first

operations were in 1899, since then 37,000,000 cu. yd. of gravel, yielding 16c. per yard, has been dug. This is 80% of the total yardage dredged in the State. Four boats are now at work. These are electrically driven. They handle 96,270, 82,709, 82,415, and 300,000 cu. yd. each, respectively, per

2117 ft. at a cost of \$4.97 per foot. In the Combination mine the north and south drifts at 180 ft. depth yielded 52 tons of \$24.39 and 144 tons of \$26.25 ore, respectively. On the 333-ft. level of the Laguna-Red Top, sill 10610 produced 82 tons assaying \$10.34 gold and 2.46% copper.

GOODSPRINGS. On September 15 the Yellow Pine company distributed 10c. per share, equal to \$100,000. This makes \$700,000 for the current year.

MANHATTAN. Development in the White Caps mine continues to be satisfactory, especially at 300 ft. A new vein in limestone, parallel to and 20 ft. from another, is 14 ft. wide, assaying \$21 per ton. It is more oxidized than any other ore at this depth. A 10-drill compressor is to replace the present one of 4-drill capacity. Milling machinery has been ordered.

Dexter lessees are sending ore to the War Eagle mill. Wittenberg & Mushett have resumed work at the Big Pine mine and mill. The new ore-shoot contains 200,000 tons. Instead of screening the ore as before, the crusher product is sent direct to a combination mill designed by the owners, which reduces 300 tons daily, using 65 hp. With Tonopah people W. & M. have bonded the Wall claims near the Manhattan Summit. Prospects are good.—The Train & Chase lease on the Mustang is producing \$100 ore. The shaft is down 225 ft. on the incline, showing improvement.

In the past six months the Big Four lessees had four lots of ore treated, yielding \$40, \$49, \$52, and \$125 per ton, respectively.

New ore-shoots have been opened on all levels below 250 ft. in the Union Amalgamated. The ore milled improves steadily.

The Commercial company, and lessees Nelson & McFarland, Ray & Kryder, and on the Seyler-Humphrey report good results.

ROCHESTER. In the Four J workings of the Rochester Mines Co. a 4-ft. vein of \$35 ore has been cut, 200 ft. west of any other vein in the mine. The company is constructing a 2-mile aerial tram from the mine to the mill, thus dispensing with the ground tramway. Machinery to bring the mill's capacity to 200 tons is now arriving.

SEVEN TROUGHS. After unwatering its 1700-ft. level the Coalition company has resumed mining. No great damage was done by the water.

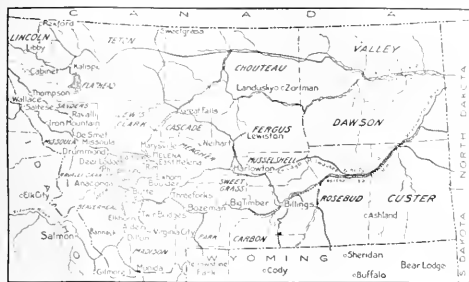
TONOPAH. Ten mines last week produced a total of 9247 tons of ore valued at \$192,326.—During August the Tonopah Mining Co.'s yield was 8098 tons averaging \$15.50 per ton. The profit was \$59,570.—The Extension company has resumed sinking its Victor shaft to 1800 ft. depth.—The Tonopah Western Consolidated Mining Co. has been incorporated by Butte and Boston capital to develop 700 acres between the Tonopah Bonanza and Great Western properties. R. H. Gross of Boston is president. Important results are expected.

NEW MEXICO

MOGOLLON. The Socorro Mining & Milling Co. shipped approximately 70,000 oz. of bullion from operations in August, and the Mogollon Mines Co.'s output for the period was over 50,000 oz., a total of more than 21 tons of gold and silver for the month, in addition to several tons of high-grade concentrate. From a portion of this district, 3 miles wide by 5 miles long, more gold and silver is being regularly produced than in all the remainder of New Mexico combined.

SOUTH DAKOTA

HILL CITY. The new mill of the Hill City Tungsten Production Co. is now receiving custom ore. The plant has a capacity of 150 tons of ore daily. It is part of the old Harney Peak tin mill. The process is as follows: storage-bin, jaw-crusher, 30 by 14-in. rolls, screens, Vexin sampler, elevator, storage-bin, pneumatic jig to remove mica (a nuisance in the Black Hills), screens, trommels, jigs, Willey tables, Deister-Overstrom slime-tables, and flotation and canvas plant for final treatment.



MAP OF MONTANA.

month. No. 4, in May 1915, moved 411,000 cu. yd. in 82½ running time. Eighty-five men are employed to operate these four boats including office, etc. In 1915 the cost per yard was 5.99c., on an excavation of 3,632,677 yards. Little success has been reported from attempts to dredge outside of these districts of Montana.

NEVADA

(Special Correspondence.)—The Eureka district, one of the oldest in Nevada, again reports considerable activity. The Eureka Mining Bureau has been formed to assist operators and investors. The California mine is being vigorously worked by lessees, and shipments of \$40 to \$50 ore are made. New shoots have been found in the vicinity of the rhyolite, an unusual occurrence in this district. Similar conditions prevail at the Mortimer.

A new shaft is being sunk at the Connolly and mine buildings are under construction. Several lessees are shipping good-grade ore. The property is worked by New York capitalists. H. G. Catlin is manager.

Other active properties are the Huebner, Marne, Bullwhacker, Barton, and Cyanide. Developments are particularly brisk on Prospect mountain and in California gulch.

Eureka, September 16.

(Special Correspondence.)—A fair potash deposit has been discovered by Henry Osborn and associates in Big Wash canyon in the south-western part of White Pine county. Numerous tests return 4½ potash. A bond has been taken on the deposit by San Diego people, and work started. An abundance of water is available.

Shipments of gold-silver-lead ore are being made from the Elliott property at Lyon Springs, near Kimberly. The mine produced rich ore years ago, but has not been active for a considerable period. It recently passed into the hands of W. S. Elliott, formerly of Goldfield.

Tungsten mining at Bonita continues active. The Bonita group is producing scheelite and the mill is working steadily. John B. Tilford is managing-owner. Some ore is going to the mill from the Richardson and Poppish mines. Prospecting is active.

Ely, September 8.

BATTLE MOUNTAIN. We have received information from Breitung & Co. Limited of New York that it has purchased the Plumas Goodwin group of claims in the Galena district, 12 miles south-west of Battle Mountain. The property is to be further developed.

GOLDFIELD. Final figures of the Goldfield Consolidated for July are as follows: 26,700 tons of ore gave a profit of \$30,016. Net costs amounted to \$5.63 per ton. Development covered

An interesting feature of the district is development of the Cowboy mine, which is estimated to contain 600 tons of 1.6% tin ore.

UTAH

ALTA. At a depth of 289 ft. the diamond-drill has passed through brecciated limestone in the Emma mine. Another hole has been started 50 ft. south. The geological results are watched with interest.

As ties and rails for the Salt Lake and Alta railway have been delivered at Wasatch it is expected that the new line will be complete within a month.

The Wasatch Mines Co. has finished the open-cut for the portal of the 4000-ft. adit to be driven, and machine-drills are now pushing ahead in solid ground.

TINTIC. August profits of the Iron Blossom were \$15,000, in spite of small shipments on account of the smelter embargo.

The Grand Central company is to use electric motors for hoisting and air-compressing. C. E. Loose controls this property.

A recent carload of ore from the Gemini realized over \$13,000. The assays of two lots returned 0.04 oz. gold, 628.63 oz. silver, 2.33% copper, and 9.6% lead; and 18 oz. gold, 5730.7 oz. silver, 6.15% copper, and 15.8% lead.

WASHINGTON

SPOKANE. Transactions on the Stock Exchange are as follows, dealings being done in Idaho, Washington, and British Columbian shares: January, 922,397; February, 780,823; March, 1,651,794; April, 1,708,191; May, 1,310,220; June, 867,836; July 266,135; and August 809,800 shares.

VALLEY. At the Spokane Belle silver mine, 32 miles north of Spokane, E. H. Belden has opened a deposit containing 20% of tungsten. The formation is granite and schist.

CANADA

BRITISH COLUMBIA

SILVERTON. In the Alpha adit of the Standard company the face now shows 9 ft. of galena that assays 75% lead and 200 oz. silver per ton, also some grey copper. The extent of the shoot is not yet known. The July profit was \$56,609. Sales of lead amounted to \$47,775, and of zinc \$63,890. Dividend No. 44 absorbed \$50,000. The balance on August 1 was \$296,381.

ONTARIO

COBALT. During August the Nipissing company produced silver worth \$203,898, from the treatment of 152 tons of high and 7254 tons of low-grade ores. The refinery shipped 306,051 oz. of bullion. At a depth of 425 and 520 ft. in No. 81 shaft the Cobalt Lake fault was encountered. It is 12 in. wide, containing calcite, and from 4 to 6 oz. silver per ton.

PORTFOLIO. Following is the Dome record for the current year:

	Tons	Gold yield	Value per ton
January	31,600	\$176,990	\$5.58
February	32,040	163,590	5.10
March	34,300	173,381	5.05
April	37,300	189,000	4.75
May	39,400	189,600	4.88
June	36,700	179,000	4.80
July	38,150	181,000	4.74
August	40,010	180,000	4.49

Costs were \$2.56 per ton during August.

In the four weeks ended August 11 the Hollinger mill treated 42,387 tons of ore averaging \$9.61 per ton. The profit was \$220,357.

The Porcupine-Crown company is sinking to 900 ft. At 850 ft. the main vein is richer than above.

A 150-ton mill is contemplated for the West Dome mine, where development has been very satisfactory.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

R. A. F. PENROSE is at Denver.

GEORGE F. OBER has returned from Hongkong to Seattle.

G. CHESTER MASTER is manager of the La Blanca mine at Pachuca, Mexico.

C. Q. PAYNE, of New York, was here this week, on his return from Oatman, Arizona.

HENRY JENNINGS is visiting the Mariposa grant, near Coulterville, California.

H. FOSTER BALN is going to China in October and is expected here on his way thither.

R. S. BURDETTE will be at San Antonio, Texas, until Mexican conditions are more settled.

E. T. MCCARTHY left London on September 4, going to the Spassky and Atbasar mines, in Siberia.

RENÉ E. RICKARD, assayer with the Seoul Mining Co., in Korea, is on his way to enlist in England.

FRANCIS CHURCH LINCOLN, Director of the Mackay School of Mines, has returned to Reno, Nevada, from Bolivia.

C. M. CAMPBELL, superintendent of mines at Phoenix, B. C., for the Granby Consolidated, is at Winnipeg, on a holiday.

WILSON W. HUGHES, formerly at Guanajuato, is superintendent for the Monitor Belmont Mining Co., at Belmont, Nevada.

T. W. GRUETTER has returned from Marysville, where the Yuba company is experimenting with his platinum-recovery process.

CHARLES F. WILLIAMS, formerly mining engineer with the Cananea Consolidated Copper Co., Cananea, Mexico, is now at Reno, Nevada.

FREDERICK G. FARISH, manager of the Lluvia de Oro Gold Mining Co., is on his way to Lluvia, Chihuahua, by way of Nogales and San Blas.

H. C. WOOLMER retires from the management of the Spassky and Atbasar copper mines, in Siberia, at the end of the current year, becoming managing director.

P. O. WELLS is at La Fundición, Peru, where he has erected a concentrator for the Cerro de Pasco Mining Co., to test its ores by gravity methods and flotation.

LYON SMITH, metallurgist with the Snyder Electric Furnace Co. of Chicago, has resigned to become assistant superintendent for the River Smelting & Refining Co. at Florence, Colorado.

H. R. HANLEY, formerly general manager of the Bully Hill mine, has been appointed superintendent of the zinc plant now under construction at Kennett for the Mammoth Copper Company.

HERMAN FLECK, for many years head of the chemistry department at the Colorado School of Mines, has resigned to engage in private business, being associated with the Chemical Products Company of Denver, of which he is one of the founders.

[Several inquiries have been received asking for a pamphlet edition of Mr. F. H. Probert's articles on the 'Superficial Indications of Copper.' We are glad to say that such pamphlets are now obtainable at this office for the nominal price of 50 cents.—EDITOR.]

ANTON HILL, the president of the South Keystone M. Co. of Amador City, died at his home at Spanaway, Washington, recently. He was a native of Germany, aged 63 years, and was identified with a number of large business enterprises in Tacoma, in addition to his Mother Lode interests.

THE METAL MARKET

METAL PRICES

San Francisco, September 19.

Antimony, cents per pound	11
Electrolytic copper, cents per pound	28
Pig lead, cents per pound	7.25-8.25
Platinum: soft and hard metal, per ounce	\$85-89
Quicksilver: per flask of 75 lb.	\$75
Spelter, cents per pound	12
Tin, cents per pound	41
Zinc-dust, cents per pound	29

ORE PRICES

San Francisco, September 19.

Antimony: 50% product, per unit (1% or 20 lb.)	\$1.00
Chrome: 45% and over, f.o.b. cars California, per ton	13.00-15.00
Manganese: 50% product, f.o.b. cars California, ton	12.00
Magnetite: crude, per ton	7.00
Tungsten: 60% WO ₃ , per unit	15.00

New York, September 13.

Antimony: This ore is firmer, but only small business has been done at prices ranging from \$1 to \$1.10, immediate delivery.

Tungsten: Business has been quieter. Small quantities are available around \$17 per unit, but most of the holders want \$20. In the recent export buying, probably 800 tons was taken for prompt shipment. Other negotiations are pending, but show a tendency to close very slowly.

EASTERN METAL MARKET

(By wire from New York.)

September 19.—Copper is active, prompt metal is scarce; lead is quiet, independents are bullish; spelter is quieter, though firm abroad.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Sept. 13.....	68.00
" 14.....	68.25
" 15.....	68.00
" 16.....	68.25
" 17 Sunday.....	68.11
" 18.....	68.75
" 19.....	68.62
Monthly averages	
Jan.	57.58
Feb.	57.53
Mch.	58.01
Apr.	58.52
May	58.21
June	56.43
July	54.90
Aug.	54.35
Sept.	53.75
Oct.	51.12
Nov.	49.12
Dec.	49.27

The above quotations indicate a market with a firm undertone, the fluctuations probably being due to demand and speculation.

Writing on August 21, Samuel Montagu & Co. of London said, "The amount of disposable silver has been so small, and the prospect of larger supplies coming out at an advance in price so slight, that buyers for coinage—a demand as implacable as ever—have not found it worth while to compete for what was offering. This policy was the more justifiable owing to the large amounts obtained from China recently, when sales were made freely from that quarter. During the week the China exchanges had a hardening tendency, and further sales seem unlikely at present. The hindrance to Mexican mining, which may be prolonged, will have the effect of further reducing the annual output, and a strong statistical position will be created. Demand promises to be more urgent than ever, especially should China be compelled to replace, or even more than replace, the heavy sales of the last year or so, while the quantity of supplies will be decidedly less."

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Sept. 13.....	28.12
" 14.....	28.25
" 15.....	28.25
" 16.....	28.37
" 17 Sunday.....	28.37
" 18.....	28.37
" 19.....	28.37
Aug. 8.....	25.58
" 15.....	26.75
" 22.....	27.62
" 29.....	28.00
Sept. 5.....	28.00
" 12.....	28.06
" 19.....	28.29

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26
Feb.	14.46	14.38	26.62	Aug.	12.34
Mch.	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.02	Oct.	11.10
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.47	Dec.	12.75

August returns were: Arizona Copper, 4,800,000 lb.; Greene Cananea, 5,000,000; Chile Copper, 3,020,000; Shattuck-Arizona, 1,699,575; Utah Copper, 20,000,000; Mohawk, 1,049,460; Wolverine, 517,851 pounds.

Shattuck-Arizona pays 75c. and 75c. on October 20; Superior Copper pays \$1 on October 10; also Ahmeek \$4 on the same date.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Sept. 13.....	6.75
" 14.....	6.75
" 15.....	6.75
" 16.....	6.85
" 17 Sunday.....	6.75
" 18.....	6.85
" 19.....	6.85
Aug. 8.....	5.98
" 15.....	5.95
" 22.....	6.22
" 29.....	6.73
Sept. 5.....	6.67
" 12.....	6.73
" 19.....	6.80

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.56
Mch.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.88
June	3.90	5.75	6.88	Dec.	3.80

Net earnings of the A. S. & R. Co. for the first half of 1916 were \$11,145,693, against \$5,019,981 in this period of 1915. Preferred shareholders received \$2,959,490, and common \$1,503,240, the latter a gain of \$503,240. The surplus on July 1 was \$6,642,958, an increase of over \$5,600,000.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Sept. 13.....	9.25
" 14.....	9.37
" 15.....	9.50
" 16.....	9.50
" 17 Sunday.....	9.50
" 18.....	9.50
" 19.....	9.62
Aug. 8.....	8.69
" 15.....	8.54
" 22.....	9.43
" 29.....	9.37
Sept. 5.....	8.87
" 12.....	8.87
" 19.....	9.46

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.14	6.30	18.21	Aug.	4.75
Mch.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.63	16.01	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

On September 15 the Interstate-Calahan company declared a quarterly dividend of \$1.50 per share, equal to \$697,485. This makes \$2,092,455 for 1916, and \$4,649,900 since April 1 of last year.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. Price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Aug. 22.....	72.00
" 29.....	77.00
Sept. 5.....	77.00
" 12.....	75.00
" 19.....	75.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	38.25	51.90	222.00	July	37.50
Feb.	39.00	60.00	295.00	Aug.	38.00
Mch.	39.00	78.00	219.00	Sept.	37.25
Apr.	38.90	77.50	147.60	Oct.	33.00
May	39.00	75.00	30.00	Nov.	33.51
June	38.60	90.00	74.70	Dec.	33.10

Spanish quicksilver in London is quoted at \$85.20 per flask, an increase on recent quotations of \$75.

TIN

Prices in New York, in cents per pound.

Date	Monthly averages
Jan.	37.85
Feb.	39.76
Mch.	38.10
Apr.	36.10
May	33.29
June	30.72
July	31.60
Aug.	30.20
Sept.	32.10
Oct.	30.40
Nov.	33.51
Dec.	33.60
1915.	34.40
1916.	41.76
1917.	42.60
1918.	50.50
1919.	48.25
1920.	51.49
1921.	39.16
1922.	42.07
1923.	38.71
1924.	38.88
1925.	33.12
1926.	33.60
1927.	33.50
1928.	33.60
1929.	33.60
1930.	33.60
1931.	33.60
1932.	33.60
1933.	33.60
1934.	33.60
1935.	33.60
1936.	33.60
1937.	33.60
1938.	33.60
1939.	33.60
1940.	33.60
1941.	33.60
1942.	33.60
1943.	33.60
1944.	33.60
1945.	33.60
1946.	33.60
1947.	33.60
1948.	33.60
1949.	33.60
1950.	33.60
1951.	33.60
1952.	33.60
1953.	33.60
1954.	33.60
1955.	33.60
1956.	33.60
1957.	33.60
1958.	33.60
1959.	33.60
1960.	33.60
1961.	33.60
1962.	33.60
1963.	33.60
1964.	33.60
1965.	33.60
1966.	33.60
1967.	33.60
1968.	33.60
1969.	33.60
1970.	33.60
1971.	33.60
1972.	33.60
1973.	33.60
1974.	33.60
1975.	33.60
1976.	33.60
1977.	33.60
1978.	33.60
1979.	33.60
1980.	33.60
1981.	33.60
1982.	33.60
1983.	33.60
1984.	33.60
1985.	33.60
1986.	33.60
1987.	33.60
1988.	33.60
1989.	33.60
1990.	33.60
1991.	33.60
1992.	33.60
1993.	33.60
1994.	33.60
1995.	33.60
1996.	33.60
1997.	33.60
1998.	33.60
1999.	33.60
2000.	33.60

Tin is steady at 38.50 cents.

Eastern Metal Market

New York, September 13.

The market in general presents a better aspect.

Copper is active both on domestic and foreign account, and prices are stronger. Near-by metal is scarce, some of the producers having little or none to offer until November.

A great deal of zinc has changed hands, brass mills and export agents having been good buyers.

Independents have been taking premiums for prompt deliveries of lead, and it is anticipated that the leading interest will advance its quotations.

Tin has been dull and uninteresting.

The antimony market has continued to sag, and some producers are unwilling to sell at quoted levels.

Aluminum is stronger.

The iron and steel market continues to gather strength. A most serious problem for all concerned is that of deliveries. Small boiler-makers who do not buy far ahead are in distress for want of material, and some say they may close their shops. Eastern Pennsylvanian mills have inquiries for at least 75,000 tons of plates from consumers who fear that the Government naval program will absorb 1917 capacity to an extent which will leave them in the lurch. Prompt-delivery plates command 4c., Pittsburg. Now steel capacity in operation since January 1, or to be in operation by the end of the year, represents an additional tonnage of about 3,200,000 tons of steel ingots, yet it has made but little impression on the situation. The foundry pig-iron market is more active, but prices show little change. The metal-working machine industry is about normal.

COPPER

With producers asserting themselves to be well sold-up on near-by metal, some saying they have none to offer, that is, any quantity of consequence, this side of November, the making of prices for near-by deliveries has been practically left in the hands of re-sellers, and it begins to look as if the latter's stocks were becoming small. Near-by metal is unquestionably scarce. September and prompt copper is held at 28 to 28.25c. by re-sellers, while first-hands quote 28c. for November, 27.75c. for December, and 27c. for first quarter. Domestic consumers have been active in purchasing fourth-quarter metal, and there are in existence many inquiries calling for that position. The market has been strengthened by the placing of new orders for brass rods and other munitions' materials, while the Allied governments are negotiating for a large quantity of copper, stated to be 125,000 tons. The contemplated order has been under consideration for some days, price apparently standing in the way of its consummation. It is reported that Great Britain is willing to pay 26c. Late last week Russian interests placed an order for 5000 tons. The foreign business is mostly for 1917. For some October metal for shipment to Russia, 28.50c. was paid. The brass and copper mills are busier than they have been at any time in recent months. Two or three are out of the market for the remainder of the year. For rods, one interest asks 39c., although up to the present time others have asked 34c. Many of the rod mills are using brass turnings, which are suitable providing they do not contain over 3% of lead. France, through J. P. Morgan & Co. has been an eager buyer of these turnings. Brass wire is difficult to procure. It is quoted at 38 to 39c. per lb. The London copper market is stronger. Spot electrolytic, the base of quotations, was cabled yesterday at £132 against £130 a week previous. Exports from September 1 to 13 totaled 10,472 tons.

ZINC

The market has been active in the past few days, and a large quantity of metal has changed hands. Foreign interests have

bought heavily, while the domestic brass mills have placed orders to cover new War orders. Prompt zinc was quoted yesterday at 9.25c., New York, and 9c., St. Louis. For last quarter about 9.12c. New York, and 8.87c. were asked, and paid. Near-by metal is scarce, not so much because of any actual shortage, but because of the disposition of producers to hold rather tightly to what they have. There is a feeling on their part that higher prices are logical to expect. A strengthening influence on the market is a prospective demand from Canada to fill a large munitions' order. It is said that the order will require 50,000 tons of prime Western, but the business has yet to be placed. Strength also has been imparted to this market by an advance at London, where the spot quotation yesterday was £52, against £49 a week previous. A London authority says that a fair business has been done in Great Britain at "very full" prices for early delivery, and that the Allied countries have bought for early shipment; also that the European markets will be chiefly influenced in the near future by sailings from America, which at present are most unsatisfactory. Exports to the 13th totaled 4015 tons, showing that heavy shipments are being maintained. Sheet zinc is unchanged at 15c., f.o.b. mill, carload lots, 8% off for cash.

LEAD

Briefly the situation is that the leading interest is not selling except to regular customers, and then only in restricted quantities, while independent producers are getting premiums. The principal producer's nominal quotations are 6.50c., New York, and 6.55 to 6.60c., St. Louis, a circumstance which has led to the prediction that the A. S. & R. Co. would announce an advance at an early date. Most of the buying has been for prompt and early deliveries. On the surface the market appeared quiet, but it gradually became known that a good business was being done, some of it with foreign consumers. In the case of a special transaction, 6.87c., Philadelphia, was paid. At London supplies are reported to be not over-plentiful. The London quotation for spot yesterday was £30, or £1 less than a week previous.

TIN

The market has been dull almost continuously since the last report, but prices have remained fairly firm, despite weakening influences. One of these is the continued offering of Banca tin at prices considerably below those for Straits. Banca has been offered as low as 36.50c. Straits (spot) was quoted yesterday at 38.25c., but consumers were not interested. Most of them are supplied with metal for which not a few paid prices considerably above those ruling today. Arrivals this month, up to the 13th, total 865 tons; there is afloat 3980 tons.

ANTIMONY

The market continues to sag, and offerings are reported as low as 11c., duty paid. The dullness is most acute, and one large Chinese producer will not take business at present levels. Needle antimony is very scarce, and holders are quoting up to 16c. per lb. with the probability that they will get this price unless supplies are augmented by new arrivals.

ALUMINUM

The quotation for virgin aluminum, 98 to 99% pure, is strong at 60 to 62 cents.

IN THE HALF-YEARLY REPORT of the A. S. & R. Co., the president, Daniel Guggenheim, states that the profit (\$11,145,694) makes an abnormal comparison with earnings \$5,019,982 in the first half of 1916. Last year prices were depressed; this year the War produced a reverse effect. Costs have advanced considerably.

Book Reviews

HOW TO BUILD-UP FURNACE EFFICIENCY. By Jos. W. Hays. P. 156. Ill., index. Jos. W. Hays, publisher, Rogers Park, Chicago, 1916. Price, \$1.

This work is in its 10th edition, revised and enlarged, and is described as a hand-book of fuel efficiency. This is an important topic, frequently discussed in technical papers, and the subject of numbers of text-books. The author apologizes for the frequent use of the personal pronoun, but says that the whole book is the result of his own experience. The author speaks straight out on boiler firing, and engineers should find something of value in the book. Some of the sketches are out of the ordinary.

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL. By C. A. Edwards, professor of metallurgy, Manchester University. P. 226. Ill. Charles Griffin & Co., Ltd., London, and J. B. Lippincott Co., Philadelphia, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$3.50.

This is a well-written book, thorough, and comprehensive. Much information has been sifted into readable form. The chemical and structural constitution of steels is described, likewise the internal changes that occur when steels are heated and cooled under varying conditions, and the transformations of the iron-carbon system. High-speed tool-steels and the various alloy steels are discussed, also the theories of hardening steels, and the effects of sulphur and phosphorus.

MOLESWORTH POCKET BOOK OF ENGINEERING FORMULAE. 27th edition. P. 865. Ill., index. Spon & Chamberlain, New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$1.50.

This standard English pocket-book has been thoroughly revised for the latest edition and an electrical supplement has been added. To those who are unacquainted with the source and character of the book, we might say that if we took Trautwine, and added a dash of both Kent and Foster and boiled down the mixture, eliminating much of the text and leaving little besides the tables and formulae, the final result would be similar to the present volume. Part of the contents is, naturally, more applicable to English than to American practice, but most of it is equally useful in both countries.

TACHEOMETER SURVEYING. By M. E. Yorke Eliot. P. 145. Ill., index. Spon & Chamberlain, New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.

The American engineer is so used to considering a transit as incomplete without a vertical arc, level on the telescope, and stadia hairs, that it might be well to explain that a transit without these attachments is called a tacheometer in England. The book is devoted to a thorough explanation of the elementary principles of stadia surveying, which the author states is not sufficiently treated in the standard English treatises on surveying. However, the material contained in the present volume is similar to that contained in several American books. In fact, the book is of slight interest to American engineers except as indicating that English practice is far behind American in some branches of surveying.

PRACTICAL SAFETY METHODS AND DEVICES. Manufacturing and engineering. By George Alvin Cowce. P. 434. Ill., index. D. Van Nostrand Co., New York, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$3.

If all the safety-first publications issued regularly by large corporations and the new books on the subject are studied by employees and the public, valuable results must follow.

Statistics are proving this so, but more lessons are needed. In the preface the author states that industrial accidents in the United States cost 35,000 lives and \$500,000,000 yearly. Also 350,000 injuries; while the minor accidents exceed 2,000,000. In the volume under review, accompanied by well-chosen pictures, the chapters deal with safety committees, buildings and fire, boilers, engines, elevators, electricity, shafting, belts and ropes, grinding tools, iron furnaces, handling materials, construction, railroads, mining, and explosives. Hand in hand with safety goes sanitation, welfare work, and first-aid, which are here well discussed. A useful book for mining and industrial companies' safety departments.

ELEMENTS OF MINING. By George J. Young. P. 628. Ill., index. McGraw-Hill Book Co., New York. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$5.

The author has fulfilled his promise when he says, "the objective of 'Elements of Mining' is to give the reader a comprehensive view of the mining problem." Although the book does not contain a great deal that is new and original, it does present a vast amount of valuable information not usually found within the covers of a single volume. It is more a compilation of known and useful facts than a treatise on the problems of mining.

Simple problems of geology and different types of orebodies are discussed in such a way as to be useful to the prospector as well as to the engineer. Considerable space has been devoted to the subject of boring and drilling. Machines used in diamond drilling, prospecting for oil and metal mining are discussed and illustrated. Separate chapters have been written on Rock Breaking, Transportation, Hoisting, Mine Drainage, Ventilation, Timbering, Different Types of Mining, Developments, Stopping, Organization, Costs, Accounting, Accidents and Miners' Diseases, and Examination of Mineral Deposits.

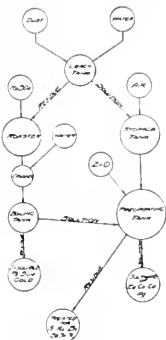
A better book could not be found by anyone desiring an encyclopedia of useful and practical information such as is needed in solving the problems encountered every day in mining operations.

ECONOMIC GEOLOGY. By Heinrich Ries. Fourth edition. P. 856. Ill., index. John Wiley & Sons, Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$4.

While the arrangement and method of treatment remain the same in this edition, considerable revision and additions have been made to the book. Many new illustrations have been added. The statistical data have been revised and brought up to date, as well as the complete bibliography to be found at the end of each chapter. The book is divided into two parts, one dealing with non-metallic minerals and the other with ore deposits. Considerable space has been given to the discussion of coal, with brief mention of the new fields in Alaska and Canada. The two opposing theories of the origin of petroleum—organic or inorganic—are fully discussed. Separate chapters are devoted to the consideration of cement, clays, lime, building-stones, salines, fertilizers, abrasives, asbestos, graphite, underground waters, and the minor minerals. The different types of ore deposits, the theories of their formation, and their classifications, are thoroughly and clearly discussed. Of particular interest is the section dealing with veins, the alterations, chemical reactions and secondary enrichments taking place in them. Typical and well-known deposits of the metals are cited and described to furnish examples of the theories of ore deposition. The chapters on the ore deposits of iron, copper, lead-zinc, silver-lead, gold, and silver have been considerably enlarged to include modern practice and recent discoveries. The more important minor metals as tungsten, mercury, nickel, cobalt, antimony, aluminum, and manganese have been given considerable attention. The book especially recommends itself as a valuable reference work, clearly and concisely written, with an unusually complete bibliography.

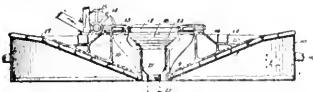
Recent Patents

1,182,320. METHOD OF TREATING FLUE PRODUCTS. Francis C. Ryan, Hammond, Ind., assignor of one-half to United States Metals Refining Company, Chrome, N. J., a Corporation of New Jersey. Filed Feb. 24, 1914. Serial No. 820,650.



1. The method of treating flue products, or other finely divided mineral bearing materials consisting in roasting the materials with excess of sulfuric acid, boiling the roast in an acid solution, separating the solution, precipitating basic salts by the addition of sufficient quantity of a neutralizing agent to leave the solution slightly acid, and separating the solution from the precipitate for further treatment to recover the metallic values therein.

1,192,806. ORE-CLASSIFIER. William Henry Weigand, Trojan, S. D. Filed June 19, 1914. Serial No. 846,080.



1. In a classifier, a concave vessel having a raised central outlet, a nozzle in said outlet, a plurality of annular, upwardly-expanding frustocone-shaped members removably associated with each other and with said nozzle and forming therewith a funnel, the level and size of which funnel in the vessel may be varied by means of said removable frustocone-shaped members, and a stirring mechanism associated with the vessel and adapted to direct the mass within the vessel from the central outlet toward the periphery of the vessel.

1,184,585. PROCESS OF TREATING ORES. Edward Harrison Snyder, Pioche, Nev. Filed Mar. 31, 1915. Serial No. 18,355.

1. A process of treating oxidized ores containing lead, zinc and other metals, which comprises leaching the oxidized ore with a hot liquid containing an alkali sulfate, and containing sulfuric acid in amount sufficient to dissolve a part only of the zinc contained in said ore, separating the resulting liquid from the ore, and rendering the same slightly alkaline to precipitate zinc hydroxide, treating the digested ore with a strong solution of caustic alkali to extract a further amount of zinc from the ore, and adding to the liquor thereby produced, an acid in amount at least nearly equivalent to the alkali present in said solution, to precipitate lead therefrom.

1,195,698. PROCESS OF CONCENTRATING CARNOTITE SANDSTONE. Herbert N. McCoy, Chicago, Ill. Filed Feb. 12, 1916.

1. A process of concentrating carnotite sands, which consists in subjecting the grains thereof to a process of attrition, and separating the value-bearing slime from the denuded grains, in water.

Industrial Notes

Information supplied by the manufacturers.

The Venturi Waste-Detector

A useful piece of apparatus for the detection of leakage and waste from the distribution mains and services of a water system, towns or mines, has recently been perfected by the Venturi Department of the Builders Iron Foundry, Providence, Rhode Island. It consists of two Venturi-meter tubes, having different but over-lapping ranges in measuring capacity, together with a mercury manometer, the whole being mounted on a frame. The smaller meter-tube is on a by-pass line above the larger tube. The manometer is of the barometric type. The inlet pressure-chamber of each meter-tube is connected by small piping to the mercury-well at the base of the instrument and the pressure from the throats of the meter-tubes communicates in a similar manner with the interior of the vertical glass-tube. The mercury is thus caused to rise and fall in the glass-tube in proportion to the difference between the inlet and throat pressures. The corresponding rates of flow in gallons per minute, or other units, may be observed on the fixed scale, the graduated portion of which is 22 in. long.

When a leakage test is conducted, the section is isolated from the general system by closing the main shut-off valves. A hydrant on the isolated main pipe is then connected by a hose line to the outlet end of the waste-detector. The inlet end is similarly connected to another hydrant entirely outside the district, the supply from which, therefore, must pass through the detector into the isolated main. This work can be done to the best advantage during the late hours of the night, when the use of water for domestic and other purposes is a minimum and when there is the least likelihood of drafts that may interfere with observations. Water is passed through the larger meter-tube first, and if the flow is so small that it fails to give satisfactory observations on the manometer, it can be diverted through the smaller meter-tube.

All possible intermediate gates are then closed successively and the changes in the manometer readings noted. Thus sensitive observations may be secured upon the amount of flow and especially upon the changes in the rate of flow into the isolated district as the various parts of the system are successively isolated. In this way the points where leakage or waste occurs may readily be determined.

The CHICAGO PNEUMATIC TOOL Co. sends us the following drilling results:

Some interesting tests of 'Hummer' drills were made recently in the igneous mica rock which is being excavated at the corner of East 149th street and Eagle avenue in the Bronx, New York. The first test was made with a type A66 little Hummer, using $\frac{1}{2}$ -in. hexagonal hollow steel, collared drill, with the following result: 20-in. hole, in 2 minutes 7 seconds; using $\frac{1}{2}$ -in. starter; 16-in. hole, in $1\frac{1}{2}$ minutes, second drill, $\frac{1}{2}$ in.; total, 36-in. hole in 3 minutes 37 seconds. The second test was made with a type C66 big Hummer, using $1\frac{1}{2}$ -in. hexagon hollow steel, collarless drill, with the following result:

	Length of drill inches	Kind of bit inches	Depth drilled inches	Time occupied min. sec.
Starter	30	*2 $\frac{1}{2}$	24	2 10
Second	54	†2	26	2 15
Third	62	†1 $\frac{1}{2}$	34	3 10
Fourth	120	†1 $\frac{1}{2}$	36	4

Total 120 11 35
*Rose. †Cross.

EDITORIAL

T. A. RICKARD, Editor

WHILE gold is depreciating, in terms of supplies, the labor-unions in gold-mining districts are agitating for a further increase of wages, mainly because the copper miners are being better paid.

MACHINERY for use in the Siberian and Ural gold-mining districts will be admitted free of Russian customs duties for the next ten years, according to a recent decree issued by the Minister of Commerce at Petrograd.

PRESIDENTIAL years are usually considered to mark a period of low-pressure business activity, but this year the approach of the election synchronizes with optimistic expansion. This is due, in part, to the recognition of the fact that no alarm is felt over the selection to be made in November.

OUR contemporary at New York, through the McGraw-Hill Publishing Co., has issued a book called 'The Flotation Process,' ignoring the fact that this title had been used for a book copyrighted by another publisher. Apart from the legal question, we desire to record a protest against this breach of good custom: the title of a previous publication should be respected, to avoid confusion and prevent imposition.

ENGINEERS and other representatives of capital sent to Bolivia to look for new mining business report that it is difficult to make a deal on the basis of developed ore, most of the likely-looking prospects having no reserves of ore or not enough to warrant purchase for the large sums in cash asked by their sanguine owners. Good opportunities exist for those willing to take hold of prospects and bring them to the next stage of development.

ANACONDA's electrolytic zinc refinery at Great Falls is making good progress, the second section, out of five, having been set to work this week. It is expected that the entire plant will be in operation early in November, producing 2500 tons of spelter per month. The first section, using 144 cells or 'tanks,' is yielding daily from 20 to 25 tons of cathodes, which are sent to Anaconda to be melted, the furnaces required for this purpose at Great Falls not having been completed. Another electrolytic zinc plant, that at Trail, across the line in British Columbia, is now producing 25 tons of spelter per day and is increasing this output as the stages of construction are slowly completed to a capacity of 100 tons daily. The electro-chemical process is the same at Great Falls as at Trail, and in each the product is a metal of great purity, which is destined to command the

market for high-grade spelter. In both localities also the cheapness of production is conditioned on the low price of electrical energy, the power-plants being controlled by the smelting companies themselves.

AMONG the curiosities of the War is the refusal of the Australian miners at Kalgoorlie to work with Slavs holding provisional certificates of naturalization issued by the Russian consul. Patriotism is expressed in a variety of ways, but we question whether this is one of them. The essential patriots have already gone to the front from Australia, so that these sensitive souls consist largely of 'slackers' or those unfit for military service. The truth is, this action at Kalgoorlie is a protest of the local labor-union against the employment of foreign labor and an effort to eject such labor from the West Australian goldfields. We are glad to add that the strike was short-lived.

DIAMONDS and other precious stones to the value of \$35,433,811 were imported into the United States during the first eight months of the current year, this amount being \$9,000,000 in excess of importations during the whole of last year. The wholesale value of these gems is about \$50,000,000 and their retail value about twice as much. As *Commerce and Finance* says, "there is no particular point to these figures except that they emphasize our extravagance." Our contemporary estimates American contributions to the various European relief funds at 5 cents per capita and the spending on jewelry this year at \$2.50 per capita, and on candy about \$2 per capita. The comparison is not pleasant, but it is true that America gave to Belgium more than money; executive ability of the highest order.

STATEMENTS are current that in Germany zinc is being substituted for copper as an electric conductor, more particularly in buss-bars. The conductivity of zinc at the ordinary temperature is about one-third that of copper and its melting-point is lower, but the chief objection is the tendency of zinc to re-crystallize under stress when used for overhead transmission of electricity. It has been suggested that a core of iron wire with outer strands of zinc be used; a steel core with aluminum strands has been employed in this country. The Germans are also using steel conductors, but this is not new; galvanized iron (more accurately, steel) wire has been used for some time in this country; when using thin wire for transmitting low voltages, the greater tensile strength of steel gives it an advantage; but for high voltages the relatively greater thickness, and weight, of

the steel wire renders it objectionable. The skin effect and corona hinder the use of iron and steel wire, particularly on high voltages. The choice of wire for a new line of electric transmission is determined nowadays only after consulting graphic diagrams showing the ratios of cost, quantity, and efficiency of the various metals usable.

COPPER received another impulse from the big deal made at New York last week, it being announced that 200,000 long tons of the metal was sold, at a little under 27 cents per pound, through J. P. Morgan & Co., to the British government. This purchase involves the sum of \$120,000,000 and represents about one-quarter of the annual production of copper in the United States. Domestic consumption also is active, the brass and wire mills having come into the market with large orders. The good fortune of the mining companies is checked only by the capacity of the refineries, which is being taxed to the limit. The erection of new plants for the purpose cannot be accomplished rapidly. At the beginning of this year the total refinery capacity was about 85,000 tons of metal per month and in September it had increased to 90,000 tons, and plant for 10,000 tons more per month is under way, but the monthly production is now 75,000 tons of American copper, to which must be added about 14,000 tons of imported crude copper, chiefly from South America and Mexico, that comes to this country to be refined.

TAXATION of mines under the British flag has become so burdensome owing to the War that a meeting of representatives of the industry was held in London on August 8 to discuss the question, under the chairmanship of Mr. J. H. Corder-James. Special objection is taken to levying the Excess Profits Tax on gold mines, which suffer from the rise in prices occasioned by the War, and the output of which, so necessary at this time, would become restricted if penalized by the proposed tax. The meeting had been convened by the Institution of Mining and Metallurgy, of which Mr. Corder-James is one of the vice-presidents. He made a clear statement of the case and referred to the joint request made by the three mining and metal societies to the Imperial Government, asking for the establishment of a Department of Mines and Minerals. This would be a great step forward in co-ordinating information and, more particularly, in recognizing the part played by mining in the economies of the Empire. Not much could be done at this first meeting, but a committee was selected from among the leaders of the non-ferrous metal mining business centred in London. We give the names because they were selected by a special committee of the Institution and indicate 'Who's Who' in the financial world interested in gold, silver, lead, tin, and copper mining at the British metropolis. The committee consists of Lord Harris, Sir Lionel Phillips, Sir Alfred Mond, Sir Trevor R. Wyne, Messrs. F. W. Baker, Edmund Davis, F. A. Govett, F. H. Hamilton, Henry C. Taylor, Leslie Urquhart, Oliver Wethered, and Robert Williams.

Copper Quotations

We have received a couple of letters asking us to explain why our average quotation for copper in July was 25.66 cents per pound while that of our contemporary at New York was 23.86 cents. A similar query was addressed to the editor of the *Engineering & Mining Journal*, and his reply was that he quoted "always the major market, i. e., the sale of the bulk of the copper. If somebody else did not have such comprehensive data as we have every week, and consequently gave undue weight to the relatively small sales of copper for prompt delivery, he would get a higher average than we would on the bulk of business." Our own reply has been delayed by the absence of the present writer in British Columbia. We reply now.

The prices reported to us by our New York correspondent, who is not connected directly or indirectly with any dealers, brokers, or producers of copper, are intended to be a guide to the consumer, not to establish a basis for contracts, whether for ore or labor, legitimate as this may be. As to that we must postpone discussion until next week. We give the average of prices prevailing for prompt or near-by metal, thereby fixing a definite and tangible base. When prompt or near-by metal becomes so scarce that excessive premiums are asked, the delivery quoted has been advanced to include a more marketable position. The determination of this is largely a matter of good judgment, just as all market-reporting involves sensing a situation. In other trades the usual basis of quotations is the price of material for prompt or early delivery. The matter becomes complicated when future months and quarters are considered; these are treated in the text of the market report, which we publish weekly with the quotations. The editor of our contemporary says that he quotes "always the major market," meaning the sale of the bulk of copper. His returns from the producers and selling agencies must be very complete indeed if he can determine what constitutes the bulk of sales and their deliveries and prices. The sellers must bare their very souls. And their unanimity! Usually in market-reporting, where you find one man like an open-faced watch, you find ten of the hunting-case variety. It is true that the bulk of copper is sold under contracts specifying deliveries several months away, but it is true also that some choice business is done in comparatively near deliveries, and at high prices. Further, spot metal does not usually consist of 'seconds' or re-melted copper. The producers ordinarily can furnish some 'spot,' there are also dealers that buy to hold for higher prices—speculators they may be termed—also manufacturers that have overbought and are tempted to sell on an advance. All these are factors at times. As already stated, a quotation for prompt delivery is something definite, in contrast to an average price for unspecified future deliveries at a time when sales might be made for delivery in October, November, December, the last quarter, first half, and so forth. Of what use can such quotations be to a con-

sumer, and if they are not for the consumer, why not say so?

A letter from Mr. Walter Douglas has been featured in the Arizona press, and a copy of it has been sent to us. He explains why his company and others have adopted the *Journal* figures in their sliding-scale agreement with the miners. He says that the quotations of the *Journal* are "as accurate as it is humanly possible to compute them," and he compares them with those received for copper sold by Phelps, Dodge & Co. His evidence is not convincing. In 1915 the *Journal* average was 17.27, while Phelps, Dodge & Co. received 16.05 cents per pound. A discrepancy of 1.22 cents suggests inaccuracy somewhere. Referring to the *Journal's* July average of 23.865, he says that "the producing companies have been receiving, during that month, a considerably higher price for the copper which they delivered." Did they receive the 25.66 quoted by us? Certainly July was a dull period, but we do not believe that the bulk of sales went on the *Journal* average for the month, especially in view of the fact that the producers were declared to be well sold ahead and in a position where they could afford to lean back while re-sellers made their sacrifices. It is in periods of dullness that second-hands become uneasy and endeavor to force sales by offering commissions. Later in the month the re-sale metal was pretty well absorbed, and small producers were suspected of using the dealers to get business, thereby saving their own face. Ostensibly they were holding the umbrella. All this was duly recorded in our market reports. Mr. Douglas acknowledges that there was little doing that month. We have every reason to believe that our quotation reflected conditions accurately.

A Successful Engineer

On another page we publish an interview with Mr. J. Parke Channing. This, like similar autobiographical records, conveys several lessons, more particularly to the younger members of the profession. To those experienced in mining the interview does not need to be recommended, for Mr. Channing's reputation is such that anything he says is sure to provoke keen interest, especially when he has been driven by the editor into a reminiscent mood. The story of this engineer's life is an endorsement of a special training. Mr. Channing is a representative product of the Columbia School of Mines. Having known a number of the men in his class at Columbia and in the classes immediately preceding or following that of '83, we have concluded that the 'early eighties' was a good time for the incubation of talent at our premier mining school. In analyzing the causes contributing to the professional success of the Columbia men at that time, more especially, we have decided that it was due to two factors: first, they came from the older mercantile communities of New England, from New York or Boston, from among families endowed with keen wits and business acumen. In later years the Columbia Mines students have been recruited from all over the continent, but thirty years ago the attendance was pre-

dominantly from the Eastern seaboard. We are more certain about the second factor: an excellent schooling in mathematics. "Do ye ken Van Am?" Undoubtedly the thorough mathematical teaching given to two generations of graduates by J. H. Van Amringe played a notable part in giving the United States a number of highly efficient men, in every walk of life, particularly engineering. For instance, in the latest victim to our interviewing campaign, we detect the ability to employ mental arithmetic, skill in selecting salient figures and making correct inferences therefrom, and above all, that constructive imagination whereby the engineer can foresee his work before he starts to do it. Mr. Channing is an assiduous collector of information on technical subjects, and he is a willing exchanger. He has the co-operative trait, which blesseth him that giveth no less than him that receiveth. We have been told by some friends of his, with whom he pioneered the first automobile into the Nevada desert, that he has the quality of persistence and indubitable skill as a mechanic. On that memorable occasion—12 years ago—he exhibited the marks of a 'good sport,' under trying conditions. We know that he has the sense of humor, without which life would be a Nevada desert, for he tells Cornish stories with a verisimilitude that would deceive anybody not born at Camborne or Redruth. But he learned more than this from his Cornish friends in the copper and iron regions. He imbibed some of their inherited sense of mining when in his younger days he consorted with such worthies as John Daniell and Joseph Sellwood; and yet he escaped the reactionary conservatism of the Cousin Jack, as is indicated by his effort to get the Calumet & Hecla staff out of a weary rut. That was a striking episode in his career. We sympathize heartily. His criticism, then and now, was thoroughly sound. It is delightful to see the young man whom those Bourbons of mining denounced, because he tried to introduce progressive methods, able now, by reason of success and reputation, to pay them his compliments. It appeals to our sense of justice. Since the date of our interview, the Calumet & Hecla deal for the purchase of the Tamarack has been declared off. Next we come to copper mining in Utah, Nevada, and Arizona. Each of these episodes proves the value of cumulative observation and experience. Acquaintance with copper deposits at Butte and Clifton permitted Mr. Channing to come to a quick decision as to the value of the Highland Boy mine. In the Tennessee undertaking, he drew upon his Lake Superior experience of mining and his Montana experience of smelting so as to incubate a highly profitable enterprise. Again, the Nevada Consolidated story shows how the three days spent at Clifton, with its hint as to how a disseminated copper deposit could be exploited to advantage, paved the way for another success. Incidentally, it makes a mining engineer feel old to recall the days when a 2 or 3% copper orebody made capitalists sneeze. Only a dozen years have passed, but a great change has come over the face of the copper industry. Finally, we have the Miami story. That suggests that if you throw your bread on the waters it may return to you buttered

after many days. In short, a small incident may be fruitful of big results. Above everything, it proves the usefulness of a knowledge of men: of becoming acquainted with as many of the personnel of mining as possible. Thus the chance meeting with Mr. Alsdorf in 1885 gave Mr. Channing the opportunity 11 years later to develop and exploit the Miami mine. He made fine use of it. The Miami business likewise illustrates the successful working of an exploration company, and the manner in which, under proper guidance, such speculative ventures can be made highly remunerative. The reader will find that the interview closes with interesting replies to some of our leading questions. The American mining engineer nowadays does, we believe, spend more time underground than he used to do twenty or thirty years ago. We agree with Mr. Channing that it is there—in the finding and breaking of ore—that the best scope for economical betterment is to be found. Yet, we query whether metallurgical ingenuity has been exhausted. The revolution made by the flotation process is too recent for the belief that we have reached the limit of perfection in that art. As to the finding of ore, all we know is small indeed when compared with the knowledge we lack on this vital subject. There is also the basic problem of human efficiency and the adjustment of the human relation between employer and employee. In this department Mr. Channing takes a keen interest. He has contributed, in many ways, to the campaign for 'welfare.' In matters appertaining to his profession, he has proved public-spirited. For instance, he was a founder of the Mining & Metallurgical Society of America, an organization that, like the Progressive party, was destined to discipline the older institutes rather than lead its members to see a higher light. Mr. Channing has taken part in the effort to reform the mining law. In short, he has shown how a mining engineer can be a highly specialized instrument of industry and also a good citizen. He has justified his education.

Suggestions to Authors

In this issue we publish a lengthy excerpt from a bulletin just issued by the U. S. Geological Survey in which the official editor of the Survey's publications, Mr. George M. Wood, has embodied much excellent advice to the members of the staff on the writing of geological reports. We have selected that part of the bulletin which seems most immediately interesting and useful to our own readers. That it will prove useful we have no doubt; advice of this kind is badly needed among mining geologists and others; therefore we take particular pleasure in giving publicity to Mr. Wood's brochure. We recommend our engineering friends to write to the Director of the Survey and obtain a copy of this publication. It contains a great many valuable hints and much pertinent suggestion. Numbering ourselves among those anxious to improve the expression of technical information in writing, we are glad to find so little with which to express disagreement from the editor of the

Survey. Only in one detail do we differ: he seems to have scant appreciation of the function of the hyphen. An editor that approves 'clay slate,' 'basalt tuff,' 'field notes,' 'rewriting,' 'surface water,' 'building stone,' and 'oil lands' must have no more use for a hyphen as a mark of connection than a patriotic American in a political campaign. Mr. Wood explains the scheme adopted by the Survey for the employment of hyphens in petrographic names, but it does not commend itself, and his ignoring of the hyphen where it is clearly demanded warrants the belief that he misunderstands the use of it. But in that respect he is not singular. The discriminating use of the hyphen would do a great deal to improve the clearness of technical writing, in which the compounding of words is so frequent by reason of the effort to be concise. However, that is a minor matter. The advice quoted in four pages of this issue represents only 9½ pages out of a pamphlet having 120 pages. We have reproduced the advice originally prepared by S. F. Emmons, with later revisions by Mr. F. L. Ransome, himself a geological writer of recognized literary distinction. 'Suggestions as to Expression' is the heading of another chapter in which general counsel of the most practical kind is offered to those desiring to learn how to improve their writing. Then come hints on the fundamental principles of composition, illustrated by quotations showing common blunders in construction. Words and phrases that are habitually misused are passed in review. We note with pleasure that the unintelligent use of 'value' is condemned and 'ore' is defined as 'mineral or rock from which one or more metals may be profitably extracted.' It is a notable step forward when the official geologist accepts this definition, for it was the idea of a mineral deposit without reference to its economic value that formerly caused so much confusion. A vein of quartz containing a trace of gold may be an interesting geologic structure, and the sinking of a shaft or the driving of a cross-cut into it may afford information of scientific value, but 'ore' it is not, because it cannot be exploited to advantage. This fact is recognized in the definition accepted by the Survey. Grammatical errors and problems are discussed in an enlightening manner; the author gives a summary of the features of a good manuscript; then typographic style, proof-reading and correcting, with directions for the typewriter, occupy the closing pages. There is no geologic information in this bulletin, nevertheless it constitutes one of the most valuable contributions of the Survey to the science of geology. Much current knowledge on the subject is either lost in turbid expression or discounted by inept writing. Sundry publications of the Survey itself, in former years more particularly, give point to such reflections. It would be ungenerous not to recognize that during the last two decades the style of the Survey's reports has improved to a level far above the average of the technical writing appearing in professional transactions and we do not doubt that the sincerity of purpose exhibited by the editor of the Survey in this publication has been a factor in promoting that result, of which the public has been the beneficiary.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Prospecting: A Suggestion

The Editor:

Sir—To the gentlemen who have discussed my suggestions on syndicated prospecting, which appeared in your issue of July 22, I freely admit that my ideas are open to criticism from the prospector. Frankly, I took the viewpoint of the investor who finances the prospector, the engineer, and all the contingent expenses. If my estimate that \$5000 would be sufficient to employ a party of from three to ten men as they were needed on a three months' prospecting trip seems too low, I can only say to those who differ from me that I would not undertake the business on such a bedrock basis unless I were otherwise disengaged. Nevertheless, from my own experience, I believe that the scale of compensation indicated would be a sufficient inducement for many men of the right kind, who would be glad to prospect on a daily wage with the assurance of a bonus of a thousand dollars in the event of a discovery.

In this hypothetical prospecting trip, financed by a small syndicate of investors who pooled their funds in sending a party of experienced men into one of the still open mineralized districts of the public domain, I assumed that the chances are in favor of their co-ordinated efforts resulting in the finding of an orebody that would make a dividend-paying mine. On the other hand, I discounted the loss by dividing it among 20 investors.

Let me quote two instances from experience. In the summer of 1900, after a couple of years' prospecting and other technical work in Alaska, I found myself 'out of a job' at Nome. Applying for work to the Wild Goose Mining & Trading Co., I was told that if I cared to 'mush' across country for nearly a hundred miles I could have the privilege of working 10 hours per day shoveling into sluice-boxes on Ophir creek for "five and board." I 'mushed.' A few weeks later, at the end of a long shift, I suggested to the superintendent that he send me with a helper into the hills prospecting, at the same wages as before. He agreed, and let me sink a few holes on a neighboring bench. From the third to the eighth hole, ranging from 10 to 18 ft. in depth, I found 'pay' in an old channel, with the result that sluicing operations in the streambed ceased for the time and the entire 'gang' was put to work running cross-cuts into this old channel and wheelbarrowing the richer gravel therein down to the sluice-boxes. While I flattered myself that I had made a rich strike, the superintendent took the natural view that I was entitled to

no more than my daily wage, and at that time I was glad to work on that basis. Since then, the Lane interests for whom I worked have increased their clean-ups materially by employing 'grubstakeless' prospectors to work similarly under the direction of their superintendents.

There would be a wider field today for experienced prospectors if mining companies would retain more of the prospector type of men. Undoubtedly there are rich deposits near many operating mines lying undeveloped because such exploratory work is not conducted as a 'side-line' by the management. A striking instance of such lack of perspective is given below, not in the spirit of criticism, but as a simple statement of fact.

Mr. John B. Platts, of Oatman, one of the contributors to this admittedly hypothetical symposium, will appreciate the following brief history of the Tom Reed mine in the Oatman district and the development of the orebodies adjacent to it. For a full decade the managements of the Tom Reed and Gold Road properties, two miles apart, were content to confine their exploratory work to the opening up of new orebodies within the limits of their respective boundaries. On the payroll of the Tom Reed company were two efficient miners, George W. Long and J. L. Melver. From their intimate knowledge of the vein in this mine they became convinced that the continuance of the ore-shoot would be found on adjoining property. Imbued with faith in their theory, they severed their connection with the company and sank a shaft on their nearby claims. In the summer of 1914, they won their reward at a depth of 463 ft. when they struck the continuation of the Tom Reed vein and opened up the bonanza orebodies of the United Eastern mine. All honor to such men of initiative! The success of such prospectors has made the West what it is today. Yet, there may be a possible difference of opinion on the part of their former employers. It is almost needless to state that in the light of their discoveries, the stockholders and managers of the Tom Reed property must realize that the company could have been the beneficiary of such a development on the extension of its vein had it employed Messrs. Long and Melver to prospect contiguous territory on the basis of a daily wage. It may be said that under the wage system men of this type would lack incentive that leads them to explore. But I suggest that the miner working underground is actuated by much the same spirit as the free prospector. Every man who is worth his three or four dollars per day underground is

normally anxious to make a good showing, and many a wise manager gives such zealous miners more or less free rein to 'follow the ore' as their judgment dictates. When such men make a 'strike' they should be rewarded with a bonus in cash or stock that will inspire others to follow their example.

The conclusions to be drawn from these instances are obviously that the mining corporations may well afford to employ skilled miner-prospectors to explore other claims or properties on the basis of a fair wage and an equitable bonus in the event of their making a real discovery. That such procedure is becoming more practical is being demonstrated by the results of exploration companies, organized in some instances as subsidiaries of operating mining companies and in other cases financed by officials of the parent enterprise. The development of some of the rich deposits adjacent to the United Verde at Jerome was initiated by far-sighted salaried employees of the older corporation. There is a wide field still open for the exploration syndicate to systematize prospecting according to modern conditions of co-ordination and efficiency. Although the 'good old days' of the prospector have gone beyond recall, there is still a great deal of work for him to do if he keeps abreast of the times, even though his status of partnership with a 'grub-staker' is being changed to that of a skilled employee of a company engaged in thorough and systematic methods of searching for hidden mineral wealth.

HAROLD FRENCH.

San Francisco, September 18.

Blasting Practice at Chuquicamata

The Editor:

Sir--In the article on this subject, published in your issue of July 8, 1916, I find several errors that might lead one astray in planning blasting operations of this kind for the first time, using the method described.

The cost of churn-drilling per foot is given as \$9.80, which is \$2 more than the drilling of our 1200-ft. holes has cost, and the cost of driving is given at \$5 per foot. The actual costs are \$3.60 maximum down to \$2.50 minimum for blast-hole drilling. The tunnel-driving costs \$10 per foot, in place of \$5, the price to the contractor alone being \$5 per foot. The tunnel-blasting is very much cheaper per cubic yard of material blasted, for the reason that less footage has to be driven between charges and because the expense of springing operations in the case of the well-drilling is dispensed with.

The factor of 463 lb. for a linear metre of line of least resistance is not a fixed quantity, but varies from this as a minimum to 600 lb., depending upon the material to be blasted. The factor of 2.61 for 60% strength dynamite compared with black powder should read 2.25. The black powder referred to is manufactured in the country and compares in blasting strength to 40% dynamite in the proportion of 1:1½ by weight.

This ratio has been proved by repeated trials. The 60% being 1½ the strength of the 40%, would give the factor 2.25.

The plan of the wiring (Fig. 1, 3, and 4) is in error, the caps here shown connecting in multiple. The article describes the caps as being connected in series, but the plan does not conform.

Further along the article states: "From careful experiments it was found that for a series of 20 caps, a current carrying 0.75 amperes under 110 volts should be used for a successful 'fire'." This is an error, for the reason that experiments pointed out that by stepping up from one-fourth of an ampere the 0.75 of an ampere was the least current that would explode the 20 caps in series. From these and other experiments, and from experience in blasting, it was determined never to use less than a safety factor of 4, which would be three amperes.

In plan No. 1 it will be seen readily that should the charges loaded be blasted the collar of the shaft indicated would be lost in the slope resulting from the blast, with the bank height indicated, namely, from 24 to 30 metres. An entrance, therefore, to the second drift could not be effected. The spacing of 15 metres has since been increased to 30 with banks whose heights are at least 1½ times this distance.

As soon as the experimental stage of this method has passed and further blasting demonstrates the most efficient spacing, charges, etc., a paper covering the details of the work will be submitted for publication in the 'Transactions.'

The method is unique in that the usual method of tunnel-blasting, namely, the 'T' or 'gopher' method, is reversed, the entrance being placed well back of the working-face and the tunnels driven from cross-cuts to the face, so that access to the second tunnel is not delayed and steam-shovel work may be continuous.

Mr. Pope Yeatman suggested, soon after operations began at Chuquicamata, that a method of tunnel-blasting would probably be more economical if the details could be worked out, and that we ought to experiment with this end in view. The results obtained to date are far better than was even anticipated, and I wish to thank Mr. H. E. Treichler and Mr. James S. Wroth for their co-operation with me in bringing this method to its present development; also Mr. Burr Wheeler and Mr. Arthur Boynton of the electrical staff, for their assistance in conducting the many electrical experiments leading to the determination of the proper current, arrangement of wiring, etc.

It is unfortunate that a work of this kind should be presented to the profession before the method was completely developed and before complete data were available.

E. E. BARKER.

Superintendent of Mines for the
Chile Exploration Company.

Chuquicamata, Chile, August 16.

MACHINERY EXPORTS in July were worth \$18,971,052.

J. Parke Channing, and Copper Mining

An Interview. By T. A. Rickard

Mr. Channing, you are a Columbia man, are you not?

Yes, of the class of '83 of the School of Mines.

I was present when you received the honorary degree of Master of Science at the semi-centennial of the School of Mines in 1914. You are a New Yorker?

Yes, I was born in New York City, in 1863, and graduated from Columbia when I was 20.

What was your first job?

My first job was with Allan Stirling, the inventor of

for the firm. The principal work was that of keeping the accounts, taking orders, collecting bills, and very frequently, helping in the foundry. We used to cast the heavy shoes that were needed for the steam-stamps; these weighed about 1000 lb. apiece, and were made with a good deal of manganese and cast with a very high 'header.' The peculiar iron from which these shoes were made contracted a great deal in the process of cooling, and the loss by contraction was supplied by the melted iron from this header. In order to keep the header flow-



THE SCHOOL OF MINES BUILDING, COLUMBIA UNIVERSITY. THIS BUILDING WAS THE GIFT OF ADOLPH LEWISOHN.

the Stirling water-tube boiler, who was at that time manager of the mines of the Hudson River Ore & Iron Co. at Linlithgo, a few miles below Hindson, in New York State. My work was that of chemist and surveyor, for which I got the munificent sum of \$1.50 per day.

Did you remain long at these iron mines?

No. I remained there about three months, and then, through Professor H. S. Munroe of Columbia, I secured a position at Houghton, Michigan, as draftsman and book-keeper for the firm of S. E. Cleaves & Son, manufacturers of mining machinery.

This experience as draftsman, I expect, you found useful in your later career?

Well, to tell the truth, I didn't do very much drafting

ing, it was necessary to pump it up and down with an iron rod. This required the services of nearly every one connected with the institution, including myself. Very frequently in the evening of the casting-day, I would stand for over one-half or three-quarters of an hour with two iron rods in hand, pumping the headers of these shoes.

This gave you some useful experience?

Certainly, I obtained a good deal of practical experience regarding shop-work and mining machinery. After about a year with the firm I was taken on as an assistant to Frank Klepetko, at that time mining engineer to the Tamarack and Osceola mines of the Clark-Bigelow syndicate. The manager or agent, as he was known, was

Capt. John Daniell, one of the old-time worthies, really one of the most distinguished and progressive men that has ever operated in the Copper Country. At the time of my employment with Mr. Klepetko, the Tamarack was engaged in sinking its first shaft, and I remember that the Calumet lode was struck one Saturday night; on Sunday morning I went to the office and Capt. Daniell told me that the night before one of the drill-holes had encountered conglomerate and he had with him the sludge from this drill-hole. He proceeded to van it on a shovel, and thus produced the first copper of the Tamarack mine. I carefully saved the copper from this first vanning, and for a great number of years had it as one of my choicest possessions, but I regret to say that in the turmoil of moving from place to place it has disappeared. *In what year was that?*

That must have been in 1885. By the way, there was one little piece of work I did before going with Klepetko, and that was in the autumn of 1884 when I acted as assistant in the Copper Country for A. P. Swineford, Commissioner of Mineral Statistics; I wrote for him that portion of his report covering the copper properties. This, in itself, gave me access to all of the mines of the district.

The Tamarack workings became the deepest metal mine-workings in the world, did they not?

They did, but at the time No. 1 Tamarack shaft was sunk, cutting the lode at 2270 ft., this then deep level was considered a tremendous achievement. The No. 5 shaft eventually reached a depth of 5268 ft. vertical.

Is it likely that the Tamarack mine will be re-opened, having regard to the favorable copper market?

The Tamarack is now owned by the Calumet & Hecla Mining Co., but it is so deep that under ordinary conditions, with the low price of copper, it hardly pays to operate. I have no doubt now, with copper selling at 28 cents*, that conglomerate is being mined from it. Provision is also being made to treat the large accumulation of tailing.

By what process?

Re-grinding, water-concentration, and the new ammonia leaching process, which has been developed by C. H. Benedict. This same process is also being applied to the tailing from the old Calumet & Hecla mine itself.

Has flotation been used at Calumet?

No. Some experiments have been made upon it, but native copper doesn't lend itself easily to the process, although there is a possibility that it may be adopted for the White Pine mine on ore from the Nonesuch lode, in which native copper is found in a very finely divided form.

Do you recall any interesting incidents of your work with Mr. Klepetko?

During my stay at the Osceola, we concluded to move the stamp-mill from Portage lake, where the tailing was

filling the channel, to Torch lake. For that purpose it was necessary to construct a railroad from the mine to the mill, and to build a new mill. This was done during the summer; the mine was shut-down, and the Cornish miners put at work, much to their disgust, at grading the railroad. As it was necessary for them to shovel dirt into wheelbarrows, I remember hearing one of them say: "I'd as soon take a snake by the tail as the 'andles of a wheelbarrow." In the rock-cuts it was interesting to hear them joke about taking a "1-ft. stope off the bottom," and such similar underground phrases. I have no doubt, however, that late in the autumn when the railroad was finished, and the new mill in operation, the miners returned to their work underground with at least five years added to their lives. They went to work on the railroad thin and white, and came back increased in weight and well browned.

When did you leave Calumet?

In the autumn of 1885 I was asked by John Duncan, the assistant superintendent of the Calumet & Hecla, who, together with John Senter and several old-timers, were interested in a concession in Honduras, to visit that country and report upon their properties, and, incidentally, build a steam-boat for them on the Uluva river, so as to hold their concession. In October of that year I sailed from New Orleans on the *City of Dallas* with all the materials for a stern-wheeler steam-boat, which was to draw 2½ ft. of water, and a crew of boat-builders. We arrived at Puerto Cortez, and after starting the men at work on the boat, I made my first trip into the interior. The narrow-gauge railroad was running from Puerto Cortez to San Pedro, and from there the trip was made on mule-back. The results of my investigation of the placer deposit were disappointing; the quartz veins were so far from transportation that it was impossible at that time to exploit them profitably; the mahogany concessions proved to be mythical forests; and the amount of freight on the river was not sufficient to keep the boat in commission. I returned in May 1886 to Calumet, and at a meeting of the directors of the company they told me the only fault they had to find with me was that they had not sent me down about a year earlier.

What did you do then?

The new Gogebie range was then opening up, and these same people were interested in options in that district. They sent me over to take charge of them, and I landed in Bessemer, Michigan, in May 1886, when that town was just being carved out of the wilderness, and the streets were axle-deep in mud. Some of the prospecting was unsuccessful, but I succeeded in striking the first ore upon what was later known as the Mikado mine. On the Gogebie it was my good fortune to meet and become associated with another Cornishman, who was as good a friend and advisor to me as was John Daniell; this man was Joseph Sellwood, at that time manager of the Colby mine. I think that Joseph Sellwood was probably as progressive in the Iron Country as John Daniell had been in the Copper Country, and I have always felt that

*The date of the interview is indicated by this quotation for copper.

my career was very much influenced by the good practical advice I got from these two Cornishmen.

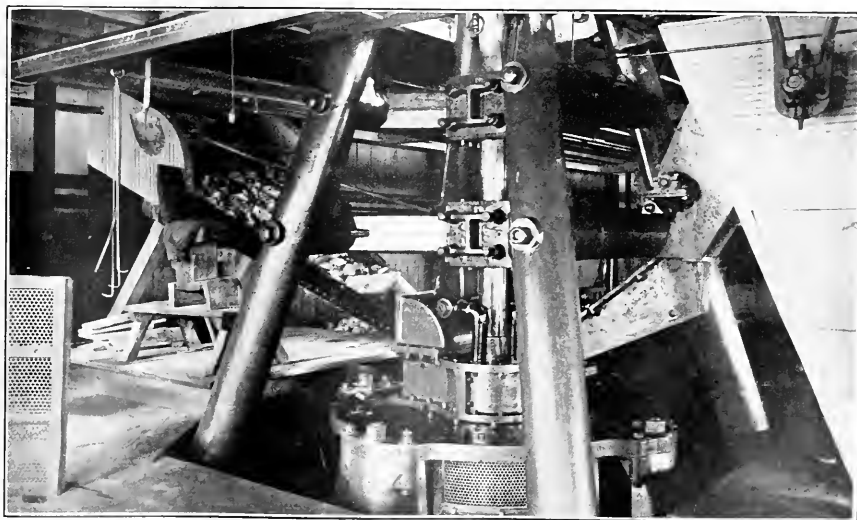
I am glad to hear you say that. It does seem to me that the combination of the hereditary mining sagacity of the Cornishman added to the technical education that Columbia gives ought to fit a man for doing the work of mining. What next?

In 1887 Michigan passed her first mine-inspection law, which provided for county mine-inspectors, and I was chosen for the position in Gogebie county. I look back now and consider that I must have had a great deal of assurance to accept a position of such responsibility, considering my limited experience. However, I got as many of the English publications as I could on mine accidents and their prevention, and the reports of Her Majesty's inspectors, and I believe that for the three years that I

ing mining themselves or having their sons educated in mining. Technically-educated mining engineers in the Lake Superior region were then few and far between. I wrote a letter to the *Marquette Mining Journal* on this subject and this was seen by J. A. Hubbell, then a member of the State legislature. He spoke to me on the matter and proceeded to get the first appropriation of \$50,000 for what is now the Michigan College of Mines at Houghton.

What was your next appointment?

In March 1890 I resigned as Mine Inspector and was made superintendent of the East New York iron mine at Ishpeming. At that time, and also for the last year that I was on the Gogebie range, I did considerable underground work for Messrs. R. D. Irving and C. R. Van Hise, who wrote the now famous Penokee-Gogebie mono-



THE STEAM-STAMP AS USED TO CRUSH NATIVE-COPPER ORE AT THE CALUMET & HECLA.

graphed the position. I did it with benefit to both the miners and the operators.

Your work as an inspector must have given you a good opportunity to gain insight into the character of those operating mines, both above and underground.

It did; not only in my own district but in that of the other districts, for we mine inspectors exchanged visits. I think that probably more than anything else my position gave me an opportunity to learn the point of view of the laborer himself, so that in later years, when I was put in positions of responsibility, I felt that I could look upon the question from both sides.

You became interested in mining education, did you not?

During my term as Commissioner of Mineral Statistics I had an opportunity of talking with a great many of the miners, and numbers of them expressed to me the wish that they might have some opportunity of either study-

graph, which was the first American work actually describing the formation of an ore deposit. In 1893 I took charge of a series of explorations for iron ore in northern Michigan; these were conducted by the Chicago, Milwaukee & St. Paul Railway Co. Most of this was in new districts, and while the commercial results amounted to nothing, a great deal of pioneer work was done which, in later years, has been of inestimable value to that portion of the State.

When did you go to the Calumet & Hecla?

In the autumn of 1894 I accepted the position of assistant to S. B. Whiting, who was then the general manager for the Calumet & Hecla Mining Co. I took this position with considerable misgiving, as it was notorious that the Calumet & Hecla mine was an Augean stable, and the task of cleaning it was Herculean. I was young and impulsive and tried to do too much in too short a time;

the consequence was that about the middle of the next year I was summarily dismissed, and I thought that my career was at an end. On the way toward Chicago I stopped at Iron Mountain and spent a day with my old friend, James MacNaughton; he was then the superintendent of the Chapin iron mine. Mr. MacNaughton was born at Calumet and knew the Calumet & Hecla mine well. He encouraged me; told me not to despair; he knew that I was right; that it was not my fault that I had been discharged. A few years later Mr. MacNaughton himself was made manager of the Calumet & Hecla, when the situation, on account of high cost and inefficient work, had become most precarious. With a ripper experience than mine, because of his successful management of the large Chapin mine, with his knowledge of the people at Calumet, with the further advantage of being a native-born son, he made the Calumet & Hecla what it is today. I remember his writing me a letter after he had been there six months, in which he said: "Channing, yesterday I gave the tree a gentle push and 500 rotten apples fell off; what will happen to it when I give it a real shake, you can imagine." By this he meant that 500 unnecessary employees had been let out. I am probably violating no confidence by saying that at the time I went to Calumet the cost per ton of 'rock' treated was about \$3.80; at the time Mr. MacNaughton had taken hold, it reached \$4.50, and under his régime the cost, in a few years, was reduced to \$2.25. I remember that when I went to Calumet I found them laboriously dumping timber into the skips, sending them down to the various levels, and then pulling them out, one at a time. I designed a timber-car, something like a flat car, which could be hitched to the rear of the skip. It had stakes on the sides and carried about 100 pieces of timber. It was no trick to hitch one of these onto the skip, lower it to the level, and dump off the timber, but the old crowd at the mine decided that inventions of this kind were not to be desired and so my skips were relegated to the boneyard. After MacNaughton took over the property, he saw these cars one day and asked what they were, and was told they were the "Channing timber-cars." He said they looked good to him, put them on, and they have been in use ever since. This simply shows the old-time reactionary spirit against which Mr. MacNaughton and myself had to fight.

Were you not, Mr. Channing, later employed by the Calumet & Hecla company to do some special work?

Yes. In 1910 the Calumet & Hecla, which had acquired interests in 11 other Lake Superior copper properties proposed a consolidation of the 12. It was necessary to have some independent engineer make a report as to the relative value of the properties for this consolidation, and so, 17 years after I had been dismissed from the employ of the company, I was selected to do this work for them. Unfortunately, there was sufficient opposition to the consolidation to prevent its becoming an accomplished fact, but I, on my part, felt that the company had more than redeemed any reflection which it might have cast upon me in 1893.

So that was your first real set-back. What followed?

As I said, I left Calumet heart-broken, returned to New York, and found nothing to do. I had some money, and so instead of moping in an office, I spent my time in traveling through the various mining districts, seeing what I could see, making notes, and occasionally getting the job of a mine-examination. During the summer of 1895 I helped Professor Peele of Columbia with his summer school of mining in Gilpin county, Colorado, at which time I had the pleasure of first forming your acquaintance, Mr. Editor, and also, incidentally, of meeting F. C. Alsdorf, who afterward brought to me the undeveloped property which is now the Miami mine. In the summer of 1896 I helped Professor Peele again with his mining school, this time at Butte. There I again met Mr. Klepetko, who was manager of the Boston & Montana. He had just finished and was operating the then new reduction works at Great Falls. I became his assistant, and my thanks are due to him for whatever knowledge of practical metallurgy I have acquired. I remained with him for nearly a year and in '97 returned to New York, and did my first consulting work for the old firm of Lewisohn Bros.

And you have been connected with them ever since, I believe?

Yes, for 19 years now. One of the first examinations I made for them was in Arizona, in 1897, when, as a matter of curiosity, I visited the Clifton-Morenci district, where I saw the first 'porphyry copper' mining in the United States. James Colquhoun was then in charge of the Arizona Copper Co. and was sending down the incline to his concentrator ore that looked more like burned lime, with occasional specks and veins of black in it, this being the chalcocite. The three days that I spent in this locality impressed upon me the fact that huge masses of such low-grade material (and in those days we called 3% ore 'low-grade') could be made of commercial value. It was either on this trip or the succeeding one that Lewisohn Bros. had me examine the Highland Boy mine, at Bingham. It was owned by the Utah Consolidated Copper Co., and had been floated in London by Samuel Newhouse at 7s. per share. The mine had been started as a gold mine, using the cyanide process, but the large amount of copper in the ore seriously interfered with cyanidation. In driving one of the lower adits to develop the mine, which at that time showed only oxidized ore, they encountered a large body of sulphide copper ore. Shipments were running as high as 18% copper, with large values in gold and silver. At the time of my visit quite an area of ground was opened up on No. 5 adit, the average of my samples being something over 7% copper. At the time the idea of secondary enrichment was vaguely known, and while I recognized that undoubtedly some of this copper was secondary, yet I could see that enough of it was primary to warrant me in assuming reasonable persistence in depth. Lewisohn Bros. had an option on a large block of shares that had not long to run, and my first examination of the mine

simply occupied some two or three hours. I took no samples, but immediately returned to Salt Lake City and sent them a message in code that it was the best copper mine I had seen for a long time, and for them to be careful under no conditions to let their option lapse. I then

Lewisohn Bros. to drill the properties, and during the summer of 1898 this work was done, with Louis D. Huntington in direct charge of the drilling. The result showed that the ore did not run 3%, but only a trifle over 2½%, and as the price of copper was low, the Lewisohn Bros. abandoned the operation.

But that, I believe, did not end the episode?

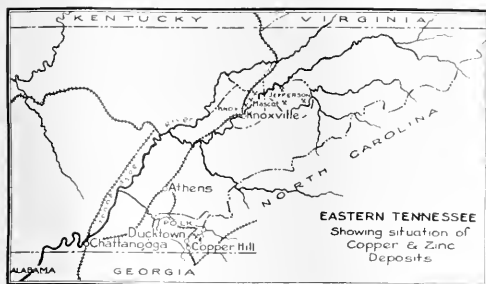
No; in the latter part of the next year the late Leonard Lewisohn, who certainly was a man of great sagacity, saw that the turn had come, that the price of copper was to advance, and after consulting with me as to the possible cost of treatment, took over the properties at Ducktown and organized the Tennessee Copper Co., taking in the Polk County mine, the Burra-Burra mine, and the London mine. The shaft on the Polk County mine was deepened, and two new shafts were started upon the other two. A railroad was built, a roast-yard graded, and a smelter erected on the Ocoee river at what is now known as Copperhill station on the Louisville & Nashville railroad. Predictions were made that it would be impossible to mine and treat this ore at a profit, but I felt that by combining Lake Superior methods of mining with Montana methods of smelting, copper could be produced at 10 cents per pound. The smelter was started in August 1901, my predictions of costs were fulfilled, and the property has been a producer ever since. *You became president of the company, did you not?*

returned to the mine the next day, and took my leisure in sampling and making my formal report.

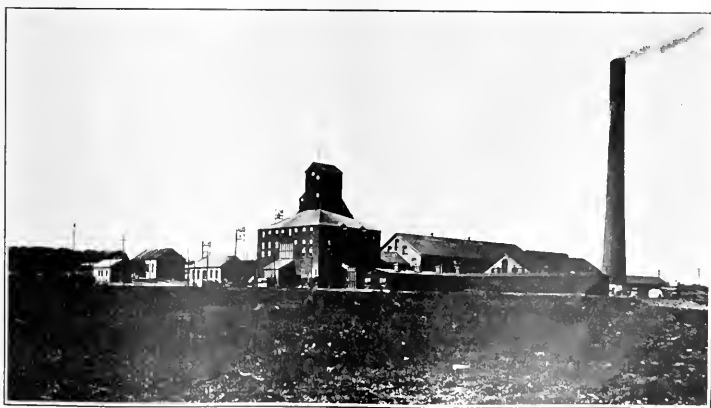
Apparently, Mr. Channing, you believe that a correct impression of the character of a copper mine can be obtained by a mere visit?

In a great many cases a man of experience will be able to pass a quick judgment on a copper mine without the necessity of laborious sampling and assaying. The Lewisohn Bros. took up their option, furnished the money for the building of a smelter, which was done under the supervision of Frank Klepetko. The mine became a large producer, and I am sorry to say that the stock was sky-rocketed from 7s. to £14, a price, however, never warranted by the condition of the mine. It was acquired subsequently by A. C. Burrage, under circumstances that were graphically, though not altogether truthfully, exploited by Thomas W. Lawson in his articles on 'Frenzied Finance.' *When did you go to Tennessee?*

In 1898 an English corporation, the Ducktown Copper, Sulphur & Iron Co. was operating the Mary mine at Ducktown, Tennessee. P. de P. Ricketts acted as their consulting engineer, and called their attention to the fact that there were several other mines in the district that it was desirable for them to add to their holdings. They stated that they had quite sufficient holdings, so Dr. Ricketts took up these options and submitted them to Lewisohn Bros. He expressed the opinion that the ore would run 3% in copper. I was delegated by the



MAP OF PART OF TENNESSEE.



ONE OF THE CALUMET & HECLA SMELTERS.

On the death of Leonard Lewisohn I became president of the company and remained so for five years.

Do you think it is judicious for the mining engineer of an enterprise to be also president of it? In other words, to what extent do you think it is prudent for an engineer to be intimately concerned in the formulation of a company's policy?

I think that the engineer, if he has business ability, should be put in direct charge of the operations of the property, and should be responsible for its outcome. It is seldom, however, that we can find "the admirable Crichton" who is a mining engineer, a business-man, an

executive, and a financial genius, but if he is a good mining engineer, a good executive, and a good business manager, then, if he is associated with good financiers, I know of no better combination.

What were your methods of smelting at Copperhill?

I was seriously tempted to begin with pyrite smelting. First, I consulted my good friend, Klepetko; he communicated with Robert Sticht; they both advised me that on a new property it was not desirable to make too many innovations, so we fortunately started with a method of smelting heap-roasted ore in blast-furnaces. After we had been running about a couple of years, W. H. Freeland, then manager of the Ducktown Copper, Sulphur & Iron Co., and now a resident of San Rafael, in your State, began the experiment of treating his ore pyritically. He froze furnace after furnace, tried hot blast and cold blast, and finally, after a year's patient experimenting, succeeded in smelting the ore successfully by the heat of its own combustion, with the addition of barren quartz and a very small amount of coke. He soon changed from roasted-ore smelting to pyrite smelting. I was glad to profit by his experience and follow in his wake. We altered the Tennessee plant so as to perform pyrite-smelting without making any changes whatever in the furnace.

Was that when the smoke troubles began?

Yes, the farmers of Georgia began to protest, the boundary of that State being only about 1000 ft. away, and the prevailing wind being from the north, it blew the smoke from the smelter in Tennessee across the boundary into Georgia. I had always felt, even from the very beginning, that there were possibilities of utilizing the sulphur of the Ducktown ores, so we started experimenting by closing up the top of the furnace, preventing the entrance of 'false air' as it is called, and started making sulphur di-oxide determinations of the gases. Much to our surprise, they ran 6% and upward. The question then arose, should we use the 'chamber' process or the newer 'contact' process. We got into communication with the Badischer Anilin und Soda Fabrik, in Germany, who sent over a corps of engineers and chemists to investigate our conditions. They were very frank in their report, and told us that our gas was so rich that it was unnecessary for us to consider their contact process, and that we would be perfectly safe in using the old-fashioned chamber process. On the strength of my recommendations the directors of our company authorized an expenditure of \$1,000,000 for the building of a sulphuric-acid plant. I called into consultation the late F. J. Falding, and between the two of us the plant was started and put into operation. We soon started making 60° B. acid, but, of course, in a new process of this kind, ran against innumerable difficulties in the way of eliminating fine-dust, and in getting the proper nitration. We succeeded, however, in getting the plant up to a capacity of 300 tons of acid per day.

To whom did you sell the acid?

To fertilizer manufacturers in Georgia and neighbor-

ing regions. A little later we made a contract with a new concern known as the International Agricultural Co. for all of our product. Later still the Lewisohn Bros. sold out, the enterprise passing into other hands. This was in 1908. Utley Wedge then took up the work where I left it. He has made many improvements, and is at present producing concentrated acid and has also doubled the size of the plant. The plant that I built has now been keyed up to a production of 600 tons of acid per day, and presumably in a year, the Tennessee Copper Co. will be producing 1200 tons of 60° acid per day from fume that ten years ago was not only a waste, but a nuisance.

Of course, the War has created an abnormal demand for acid?

It has, and, of course, it takes time to build acid plants, which is the reason that the Tennessee Copper Co. has such a good market for its concentrated acid today.

When you left the Tennessee Copper Co., Mr. Channing, if I remember correctly, you formed the General Development Co.

That's not exactly right. We formed the General Development Co. in 1906, some three years before I gave up the active management of the Tennessee Copper Co. The General Development Co. was organized for the purpose of developing prospects and taking hold of partly developed mines, with a capitalization of \$2,500,000, later increased to \$3,000,000, of which only \$1,000,000 was paid in cash. Up to date it has paid about \$1,800,000 in cash dividends and has assets of a value of practically \$5,000,000. What led to the formation of this company was that in 1904 Messrs. Requa, Bradley, and McKenzie had developed a very promising copper prospect near Ely, Nevada, this being one of the first so-called porphyry deposits, that is, a low-grade mass of silicious rock in which chalcocite is sparingly disseminated. In the winter of 1904 they were ready to raise the necessary money to develop and equip the property, build a railroad, and erect reduction works. The raising of this money was entrusted to a large banking-house in New York whose senior partner assured them that he would have no difficulty in obtaining the necessary funds in France. He went to Paris, with most excellent detailed reports by Requa, Bradley, and MacKenzie, but when he confronted the French engineers with the proposition of making money from a deposit that ran 23% copper, they laughed at him, and refused to consider it. It simply showed that they were not up-to-date, for they did not realize what could be done. So, in the summer of 1905, I was asked by the firm of S. D. Loring & Co., of Boston, to make an examination and report upon the property of the Nevada Consolidated Copper Co. It was here that my three days spent at Clifton, Arizona, in 1897 were of incalculable value to me, for I saw that with Lake Superior methods of mining and Arizona Copper Company methods of concentrating, plus the smelting practice of the Boston-Montana and the Utah Con-



THE MIAMI MINE AND MILL IN ARIZONA.

solidated, the property would be a successful venture. On the strength of my report, Messrs. Hayden, Stone & Co. and other people took stock, I believe, in the neighborhood of \$4 per share. A block of these shares was offered to Adolph Lewisohn, who declined to take them. Later on, seeing the shares advance, he approached me and suggested the organization of the General Development Co., with myself as consulting engineer.

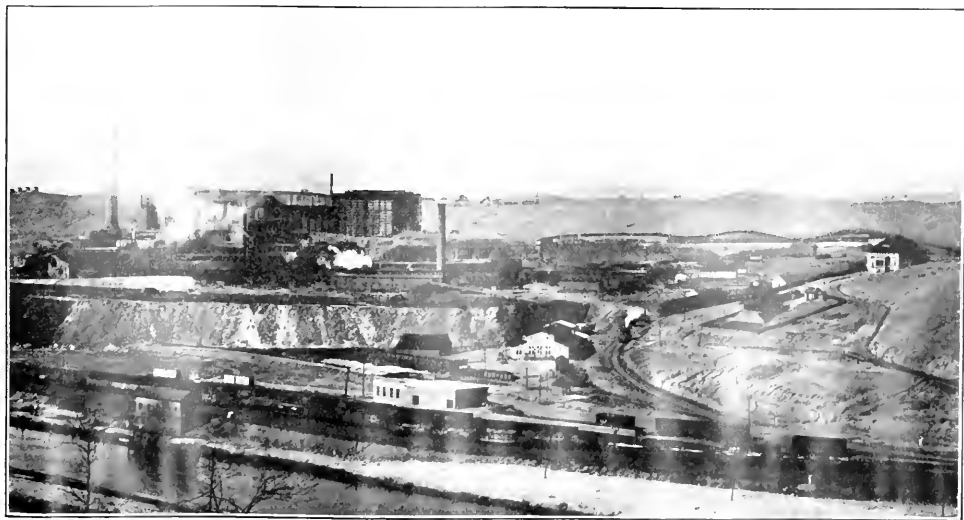
When did you find the Miami?

After the General Development Co. was started, we spent considerable money at Butte and other places without result, but in December of 1906, when visiting Globe, I ran across my friend, F. C. Alsdorf, whom I had met in Gilpin county, Colorado, in 1895. He called my attention to some ground six miles west of Globe, which,

in his experience of the Clifton district, he thought might be underlain by a copper deposit. I went over the ground with him, and looking at it in the light of my Clifton experience, and of experience with the Nevada Consolidated at Ely, I agreed with him. The General Development Co. took over the property and began development work in January 1907, and in May struck ore, at the No. 2 Red Rock shaft, at a depth of 220 feet.

What was the ore?

The copper was in the form of chalcocite, disseminated through schist, and ran about 3% copper. Although the Miami and Ray mines are both in schist, still the term 'porphyry' has become so well established that the name is used notwithstanding that in some cases the ore is in real porphyry, and in some cases in schist. The



THE TENNESSEE COPPER SMELTER, AT COPPERHILL, TENNESSEE.

Miami Copper Co. was floated in the spring of 1908 at \$5 per share, the company being organized for 600,000 shares. Of these 300,000 were issued for the property to the General Development Co. and the first 200,000 were sold at \$5 per share to provide initial working capital. Later, as the mine developed and the ore reserves increased, the remaining 100,000 shares were sold at \$10 per share. Afterward the capital was increased; and 150,000 shares were issued at about \$17 per share; it consists now of approximately 750,000 shares issued, and the total initial cash invested in development and equipment amounts to \$4,500,000, so that the original purchase price becomes relatively insignificant as compared with the cost of development and equipment.

So the price of the property was small compared with the cost of making it a mine?

No, that is not exactly right. If you consider the bare cost of this undeveloped property to the General Development Co., then Yes. The General Development Co. took the risk of prospecting and had lost money in previous ventures leading up to this one, but it sold the developed Miami property to the Miami Copper Co. for, at that time, a consideration that was \$1,500,000, namely, 300,000 shares at \$5 per share.

This venture has proved a complete success?

It has. The Miami Copper Co. is now producing over 4,500,000 lb. of copper per month at a cost of under 9 cents per pound, and it is estimated that it has ample ore resources to maintain this output for many years.

Mr. Channing, I believe your company is a defendant in a case brought by the Minerals Separations for infringement of patent rights governing the oil-flotation process.

Yes, this is a fact. The case was tried in the spring of 1915 in the U. S. Circuit Court at Wilmington, Delaware. No decision has as yet been rendered.

I take it that you are impressed with the great usefulness of the flotation process?

Yes, I am, but in view of the fact that the matter is in Court, I do not care to discuss it.

You consider mining engineering a good profession for the American boy?

I do, but I doubt whether the possible prizes are as great as they were at the time that I graduated. Still, the tendency at present is to demand more and more that technical graduates be employed at the mines, even in such subordinate position as shift-bosses, so that there always is an opportunity for a capable man to start at the bottom and work his way up. I have tried, year after year, to impress upon the graduates of mining schools that they must not think that when they get their degree they are finished engineers. They must realize that they have only the ground-work for learning the business of mining and that it is as necessary to work in the mine or reduction works to learn the business of mining as it is to work in a grocery store to learn the grocery business, or in a bank to learn banking.

Then I shall ask you whether you agree with me in considering that the American mining engineer as a rule does not get enough underground experience; in other words, that he shines most at surface, and appears to have a dislike of work underground?

No, I would not say so. I think the younger graduates who are coming out are just as ready to go underground as they are to go into the mill or smelter, and there have been such refinements in milling and smelting that the great economies of the last ten years and probably for many years to come are going to be in mining methods; there's where the great improvement is to be achieved.

What prospects can you see for the acquirement of additional skill in the finding of ore, which is, after all, the first step in mining?

The easily recognizable metal deposits of the United States probably have all been discovered. There undoubtedly remain a great many, not only of copper, but of other metals, in which a careful study of the surface conditions is required in order to lead to correct inferences. Take, for example, the question of oil. I was impressed, some four years ago, on my visit to Russia, to find that there was little 'wild-catting' or venturesome prospecting in Russia, such as there is in the United States. If there was any supposition that a certain district contained oil, possibly a year or six months was spent by trained geologists in thoroughly studying the geology, in putting down short drill-holes to determine the formation, to establish the dome or the anticline, and not until all this work had been done carefully was the first deep drill-hole started. The result has been that in Russia there are probably fewer dry holes than in the United States.

In other words, careful scientific investigation is recognized now as a first step in intelligent mining?

It is. The days of the rich deposit that anyone could exploit are over, and we are reduced to the necessity of extracting our metals from material that in the past was passed over as waste rock. To make material of this kind pay one must have a large deposit and careful geological work must be done in connection with its development. The method of mining and the method of treatment to be adopted must be the subjects of careful study and experimentation, and after the work is under way one cannot let well enough alone but must be ever on the alert to improve extraction and reduce costs.

FINELY POWDERED ALUMINUM forms a part of two of the most destructive explosives known, one of which, ammonal, is a mixture of five to eight parts of ammonium nitrate with one part of aluminum powder and is used to charge shells. It is one of the few explosives which presumably can never be used as a propellant, as its action is so sudden and the force so tremendous that no gun would be able to stand it.

GOLD OUTPUT of the Rand in August was 781,000 oz. fine, an increase of 20,000 oz. over that in July.

Future Development of the Flotation Process

By Rudolf Gahl

*The flotation process is in its infancy. For this reason the Inspiration concentrator must be necessarily in the first stages of its development. In what direction future changes may take place, is perhaps indicated by tests which have been made partly on a laboratory scale and partly on a somewhat larger scale, but which have not yet been incorporated into our regular milling process. Of these latest developments, I will try to give an outline in the following:

THE POROUS BOTTOM is, as one may imagine, the most essential part of a pneumatic-flotation machine. Our experience with the porous bottoms of the different constructions brought out clearly the principal difficulty attached to them, which is, that the pores have a tendency to contract gradually and thereby to retard the passage of air through them. This tendency was more pronounced in the solid porous bottoms employed in the Flinn-Towne flotation machine than it was, for instance, in those of the Callow type, although the latter also show a tendency in this direction. Our first supposition was that the choking was due to the fact that the air entering below the blankets carried particles of dust, which would settle in the fine pores and reduce their area. Indeed, a canvas blanket will, after a certain length of service as a porous medium, always show some ring-shaped spots of dark color opposite the air-inlets, clearly indicating that a deposition of dust particles on the blanket actually does take place. To make sure of this point we cut out round disks from a Callow blanket that had been used for some time, and investigated their porosity by using them as porous bottoms in a glass tube standing in a vertical position. Air under pressure could be applied to an air-chamber fixed underneath these disks, and the air passing through the porous blankets could be measured by a gas-meter. The quantity of air discharged through the porous medium offers a measure of the porosity of the blanket, and for this reason, the velocity or speed with which the counter of the gas-meter revolves, gives an indication of the porosity of the porous disks being tested. To our surprise, we found that the darkest points of the blanket were not those of lowest porosity. On the contrary, the points farthest away from the air-inlet showed the greatest tendency to choke. An explanation of this paradoxical behavior seems to be offered by the fact that an air blanket is kept in a state of more or less agitation near the air-inlet (in the Callow machine this happens to be a point remote from the places where it is held rigid) while farthest away from this point the

blanket assumes a state of comparative rest. Incrustations, due perhaps to the presence of soluble salts in the water in conjunction with fine slime, always form to a greater or less extent in the top layer of the blanket. Evidently, the agitation counteracts the formation of the incrustation, while there is no such influence in the portions that are essentially at rest. For this reason, we concluded that a solid porous material is not suitable as a diaphragm in a flotation machine of the pneumatic type, if a bottom of long life is required. As a matter of fact, the experience of everybody who experimented with solid bottoms seems to have pointed in the same direction. Mr. Cole for a while tried carborundum tubes in his machine. We tried carborundum stones in the flotation machine of the Inspiration type and abandoned them, and I believe that even Messrs. Flinn and Towne have, in the meantime, given up the solid bottom of their original design.

A necessary condition for a serviceable flotation-bottom appears, therefore, that the porous medium be of a flexible nature. The 4-ply canvas stitched every half-inch or so, which Mr. Callow's first cells contained and which we have used for considerable time in the Inspiration machines, seems to answer this purpose fairly well. We find, however, that to keep it in good working condition and prevent incrustations from forming on the top, we have to clean it frequently. This is done by dipping an iron pipe connected with a water-hose into the compartments and sweeping the canvas bottom with the jet of water discharging from the lower end of the pipe. The canvas blankets seem to last for about 6 months at the most. As they are inexpensive, the replacing of a bottom after that time is not a serious item in the operating costs. The giving out of the canvas is due to the wear caused by the frequent cleaning. The top layer wears out first, the holes created by the stitching forming nuclei for the formation of larger holes. By the time the top layer has a number of holes the canvas blanket is generally discarded. In the interest of greater economy, we intend giving up inter-stitching the layers of canvas. We are trying to decide whether it is better to use single sheets of thicker fabric or to use canvas similar to the kind that we have been using and to put several layers on top of one another without inter-stitching them. The latter has the advantage of requiring the discarding of only one layer, when it becomes defective.

There will always be some tendency to form incrustations so long as canvas is used for flotation mediums. Their formation will be entirely prevented only by substituting an altogether different material. We have made experiments in this direction. One of my former

*Abstract from 'History of the Flotation Process at Inspiration,' a paper presented at the Arizona (September 1916) meeting of the American Institute of Mining Engineers.

assistants. R. H. Haskel, deserves credit for suggesting them. For instance, we substituted for the canvas blankets, thin rubber sheets perforated with a multitude of needle-holes and obtained an excellent froth. The objection to their use is that their life is limited. When sheets of rubber of an increased thickness are used, the needle-holes require too much pressure to form openings of sufficient size for the passage of air, and to make a thick rubber sheet suitable for this purpose, slits several millimetres long have to be substituted for needle-holes. We have had one or two rubber bottoms of this design in operation, but, just at present we are not ready to substitute them for canvas blankets. We also tried a blanket made from a material that goes under the name of sponge-rubber and can be produced with rather fine texture. We have not been able, however, to obtain lastingly good results from the use of this medium. Furthermore, we tried a woven fabric containing rubber threads in one direction and threads of cotton or the like in the other direction and a rubberized canvas made by the Goodrich Rubber Co. We are not prepared to use any of these materials on an operating scale.

The advantage of rubber should be, in the first place, that on account of its smoothness it would have less tendency than canvas to permit the formation of incrustations. Besides, an elastic medium should have the additional advantage of avoiding the danger of catching small sand or slime particles in the pores of the medium, as an expansion of the medium (which may be effected, for instance, by increasing the pressure) would widen the pores and remove such particles. We think that our experimental work in this direction is encouraging.

THE RECOVERY that it is possible to effect in a flotation plant depends largely on the grade of concentrate desired. With a low grade of concentrate, a low tailing can be made, but when a high grade of concentrate is stipulated, increased tailing-losses cannot be avoided. A question that suggests itself in this connection, and which we have tried to answer by laboratory experiments is, "How can we raise the grade of our concentrate—that is, reduce the percentage of insoluble matter contained—without entailing additional copper losses?" We know from laboratory experiments that this can be done by expensive methods—for instance, by heating the solutions—but such a procedure would be undesirable from an economical standpoint. Experience has shown us that concentrate produced in the first compartments of the cleaner-cells is always freer from insoluble matter than the concentrate produced in the last compartments. The problem then resolves itself into finding a suitable cleaning process for the concentrate from the last compartments of the cleaning-cells. By treating this low-grade concentrate hot, with the addition of caustic soda, we have been able to separate it into a high-grade concentrate and a fairly low tailing. This method necessitates only the expense of heating a small fraction of the pulp and may be a commercial possibility.

CARBONATES. Another subject on which we have spent considerable time in our laboratory is the problem of re-

covering copper carbonates by flotation. When we started our flotation plant, we discovered, to our astonishment, that the machines not only saved a high percentage of copper sulphide but that they also recovered some of the carbonates. Ever since that time, we have tried to find means of improving the carbonate recovery.

In the first place, we studied all of the oils that seemed to have a tendency to cause the flotation of such minerals. Later on, we tried other means in addition to the variations of the oils. One way in which copper carbonates and similar minerals might be recovered was outlined by Alfred Schwartz in his U. S. patent No. 807,501. The process consists in first artificially producing a sulphide coating on such oxidized minerals by the introduction into the pulp of soluble sulphides, and then adding suitable 'oils' and effecting the flotation. If it were possible to thus chemically produce coatings of sulphide identical with the surface of the minerals formed by nature, this process would work well, as evidently the nature of the surface is the only characteristic that determines whether a mineral will float or not.

Minerals Separation owns a number of patents covering this subject. Their English patent No. 26,019, issued to Sulman & Picard, describes the flotation of oxide copper minerals by similar means.

I am not aware that equivalent patents have been issued in the United States. The English patent in question is of a later date than the Schwartz patent above mentioned. The representatives of Minerals Separation have experimented with this system, while demonstrating their machine to the Inspiration company. As far as I know, they have not proved its practicability. In the course of their experiments, they tried the application of sodium sulphide and sodium polysulphide for this purpose. The latter was produced by treating sulphur with hot caustic soda. At the time these experiments were made, I was not familiar with the chemical action taking place, which, as much as I know now, actually results in the formation of polysulphide mixed with thio-sulphates and other oxygen-sulphur compounds. The failure of their experiments, I ascribed to the fact that perhaps a polysulphide which they were anxious to make was not actually produced. I proceeded to make sodium polysulphide by the treatment of sodium sulphide solution with sulphur powder. When we applied this reagent to some of our carbonate ores in laboratory flotation experiments, we noted that a good recovery was obtained. The composition of the compound was varied in order to find just what composition gives the best results in the flotation of carbonates. Our experience seems to indicate that sodium sulphide alone encourages the flotation of carbonates, but that sodium polysulphide, or sodium sulphide containing more sulphur than would correspond to the chemical formula Na_2S gives better results. The addition of caustic soda to the sodium polysulphide was found beneficial.

The question then arose as to why we succeeded in effecting the flotation of oxidized copper when the experiments of the members of the Minerals Separation

staff failed. Tests along these lines brought out the fact that the Minerals Separation compound when applied to our carbonate ores also worked successfully, but that it did not on our regular milling ore. Our own compound when added to our mill-ore mixture increased the recovery of the carbonates, but evidently interfered with the sulphide extraction, and for this reason seemed to be of as little use as the compound of the Minerals Separation Company. When applying reagents of this character to tailings resulting from ordinary flotation treatment, with a view to effecting a sufficient sulphide extraction by the regular flotation process, and using the compound in question only for the purpose of increasing the carbonate extraction, we have found so far that the increase in copper-carbonate recovery over the one obtained without the addition of such chemical compounds is not worth the additional expense.

But this is only a consequence of the fact that carbonates exist in very small amounts only in our mill-ore and are partly saved by the ordinary flotation process.

There is no real difficulty about saving carbonates by the method mentioned if they exist in quantities that make it worth while to save them. That copper carbonates can be recovered may easily be demonstrated by treating a deslimed feed in a series-flotation machine. If at the point of the machine, where the sulphide recovery is nearly finished, sodium sulphide is added, the decidedly green color of the concentrates in the following compartments leaves no doubt on this point. The desliming of feed seems to assist the carbonate recovery.

It would be well to establish why sodium sulphide and polysulphide tend to increase the recovery of copper carbonates. A coating that might be expected to form cannot be detected. The concentrate resulting from the treatment of pure carbonate ore is decidedly green; besides, when an alkaline condition of the pulp is used there is very little, if any, tendency for any sulphide coating to form, and the alkaline state of the pulp is (as explained above) exactly the condition under which the best carbonate extraction results. Another fact that seems to contradict the explanation of these results by the assumption of a sulphide coating is, that when we proceeded exactly as suggested by Schwartz—namely, when the application of soluble sulphide was followed by the addition of flotation agents and by the actual flotation—we seemed to obtain poorer results than when the procedure was reversed by applying the oil first and following with the application of some soluble sulphide, although the latter method would certainly seem less favorable to the formation of a sulphide coating, and perhaps for this reason has not been suggested by Schwartz.

Another theory that has been mentioned as an explanation of this phenomenon is that colloidal sulphur is formed by the solution of sodium polysulphide in water, which, as is known, is a good flotation agent. For instance, it is pointed out in the U. S. patent No. 1,140,865 taken out by R. F. Bacon of the Mellon Institute in Pittsburgh, that by setting free colloidal sulphur, say, by the reaction of a soluble sulphide with sulphur dioxide, good

flotation results may be obtained as far as sulphides are concerned. To make the process available for the flotation of carbonates and other oxidized copper minerals, he suggests that a sulphide coating be first formed on the minerals, that is, to follow Schwartz's idea. Whether the colloidal sulphur by itself has a beneficial influence on the recovery of the carbonate (as has been suggested in explanation of our observations) seems rather doubtful when it is considered that we have obtained good results in alkaline solutions in which colloidal sulphur does not seem to separate out from polysulphide containing only a limited amount of sulphur such as was used in our tests. The full theoretical explanation of these facts must therefore be left to future investigations.

SILICATES. In our experiments with the object of saving the oxidized copper minerals, we soon found that we could save some of these minerals, while others were entirely refractory to the method above mentioned. To establish which minerals could be saved and which not, we attempted an analytical separation into carbonates and silicates. The chemical methods which we tried for the purpose of distinguishing between the two proved unreliable, however, and we had to resort to the separation by specific gravity (panning). The carbonates of copper (malachite and azurite) are heavier than gangue, and the silicate (chrysocolla) is lighter. The separation is rather difficult, owing to the small difference in specific gravity, and the results are therefore far from being altogether reliable, but they seem accurate enough to indicate that the method of saving carbonate copper above referred to is of value only for the recovery of carbonates and does not apply to silicates. This fact seems to be another corroboration of the assumption made above, that carbonates of copper do not float simply because of the formation of a thin surface coating of copper sulphide. It can easily be verified in the laboratory that silicates can be coated with copper sulphide fully as easily as copper carbonates. For this reason, if the filming theory is right, it should be possible to float silicates just as well as carbonates. There is no doubt that they can be floated by transformation into sulphides, only this transformation must not be confined to the surface, but must go deeper. Our experience is, that to effect a good recovery, it is necessary to acidify the pulp so strongly that practically all the silicate of copper is dissolved and by the action of hydrogen sulphide or other soluble sulphides is transformed into the state of chemically-precipitated copper sulphide. In this form there is no difficulty about the recovery of the copper by flotation, but this procedure is not entirely without objection.

In case hydrogen sulphide gas is used, the acid combined with copper is regenerated. This tends toward a low acid consumption and a good copper extraction, on account of the fact that the treatment winds up with a small percentage of copper in solution and free acid present, both of which are desirable in the light of the law of chemical mass action. But hydrogen sulphide is not a desirable reagent. The fact that it is a gas and

not a liquid introduces complications in the apparatus which are accentuated by the fact that it is poisonous and obnoxious otherwise.

Other soluble sulphides used in place of hydrogen sulphide will neutralize some sulphuric acid with the result that the acid consumption will be higher and the copper extraction lower than in case of hydrogen sulphide gas.

As far as acid consumption is concerned, it is pointed out that the free acid lost with the pulp may be settled in ponds and re-used. However, the re-use of acid diluted to such an extent is a more serious problem than is generally realized.

The treatment of concentrates that are colloidal, to a much greater extent than ores which mill-men have been in the habit of calling 'colloidal,' offers additional problems, which, however, may prove not to be as serious as they look.

Everything considered, I cannot see that the flotation treatment of oxidized copper ores after previously leaching them offers better prospects than straight leaching by decantation and precipitation by other methods.

GENERAL THEORY. It seems to me that an explanation of the qualities of the flotation-oils is not as difficult as it might appear. The problem only seems so complicated because the flotation qualities of an oil or an oil mixture have not been separated into their components. In fact, it requires a combination of qualities to make a successful flotation-oil. In the first place, the flotation-oil has to coat the mineral particles. That there is a tendency for the formation of such a coating can easily be seen from simple experiments. For instance, if samples of copper sulphide (chalcocite), copper carbonate (malachite) and gangue (silica) of the same screen size are spread out on watch-glasses and then moistened with a drop of creosote soon disappears through absorption by the copper sulphide, while it takes a much longer time for it to be absorbed by the copper carbonate and a still longer time with the gangue. On the other hand, when a drop of water is placed on the same minerals, it will disappear on the gangue first, later on the carbonate, and finally on the copper sulphide. This evidently proves that in a mixture of water and oil, the oil will attach itself with preference to the sulphide particles while the water will have the greater tendency to wet the gangue.

The second quality of a flotation-oil is that it has to form a stable froth. In such a case, the stability may be secured by more firmly cementing together the mineral, air, and oil. To accomplish this, oils are used which have a tendency to float finely-divided gangue particles. The action is characteristic of the heavier pine distillates like pine-tar and the lighter ones like turpentine if they are crude, unrefined products; in other words, when they contain some of the heavier distillates. I am not quite sure, however, whether the beneficial influence of oils of this group is not perhaps rather due to the fact that they remove colloidal material from the pulp and thereby improve its tendency to float minerals.

A third quality demanded of a successful oil-mixture is that it must be able to produce a sufficient volume of froth. This property is exemplified best by oils of the soluble type—creosol, pine-oil, and alcohols. It can be proved easily that when oils of this type are used, although they may be considered insoluble, the water acquires the frothing qualities of the oil. It may be demonstrated by shaking an oil of this character, with water and permitting the oil to separate out again. It will be found that the water has acquired frothing qualities by undergoing this treatment. It is even likely that the soluble portion of the oils belonging to this group is the only one that is active in this manner. The difference between the oils of group 1 and group 3 may be studied, for instance in a flotation machine of our type. It will be noted that the heavier mineral runs over the concentrate discharge largely in the first compartments forming a heavy dark froth and the heavy insoluble portions of the flotation oil-mixtures apparently go with it. Toward the tailing end of the flotation machines, most of this dark material has disappeared and the froth is lighter and of a more watery nature. The pulp, however, has not lost the quality of forming froth even after it gets to the last compartment of the flotation machines. This permits the conclusion that the frothing characteristics follow the tailing-pulp. The water settled in tanks and tailing-ponds has decided frothing qualities. Such water behaves in a similar way to certain alcoholic solutions with which we are used to associate this characteristic, for instance, beer or champagne. The experience of mills using the flotation process, that when the tailing-water is reclaimed the quantity of frothing-oil may be considerably reduced, further supports the assumption that the formation of froth is caused by water-soluble substances.

BAUXITE is the chief source of metallic aluminum. The great bulk of bauxite used comes from Arkansas, which in recent years has produced about 80% of all the bauxite mined in the United States and in 1915 produced more than 90%. Experiments have been made to produce metallic aluminum from alumina produced in making potassium sulphate from alunite. A process has been patented for extracting aluminum from kaolin or aluminum silicates in general. The clay is fused with sodium sulphate in the presence of sulphuric acid or with its equivalent of acid sodium sulphate, in such proportion as to form aluminum sulphate and free silica. The fusion product after cooling is dissolved in water, filtered, and treated with sodium fluoride. The aluminum fluoride which separates is fused with common salt and is electrolyzed.

As a result of the War there has been a rapid development of the manufacture of potassium chlorate in Japan. An over-supply of the product has now affected the market. There are about three factories, and the total output is placed at 7000 bbl. per month, which will be increased to 10,000 bbl. when extensions now projected are completed.

Reports on Mining Districts—General Suggestions

***GEOLOGY IN ITS ECONOMIC BEARING.** The writer should bear in mind that an economic report may be used by readers who are not geologists and should therefore avoid as far as possible technical words with which they are not likely to be familiar. If the use of such words is unavoidable it may be desirable to explain their meaning briefly.

Stress should be laid on those geologic facts that are of direct economic interest. Material that is chiefly of scientific or theoretic value and that has no direct bearing on the economic problems discussed may best be reserved for separate publication. If it seems desirable, for the benefit of specialists, to include such material in an economic report, it may, by paragraphing in smaller type, be kept distinct from the main text, so that it can readily be skipped by those who would not understand it.

ORDER OF TREATMENT. The order of treatment should follow the principle of first giving the reader a general idea of the subject under consideration before proceeding to detailed description—the reverse of the process by which the author usually arrives at his results. This suggestion applies not only to the whole report but also to the treatment of individual topics. Thus, before describing the geology of the ore deposits of a district, he might give a brief characterization like this: "It is an area of granite intruded by andesite, which is in turn cut by phonolite dikes," or "The deposits are narrow, vertical veins cutting granite, andesite, and phonolite and conforming in general direction with the phonolite dikes." In this way the reader starts with a general idea of the subject and is able to see the bearing of the facts observed and presented by the author.

SUBJECT ORDER

GENERAL ORDER. The general order treatment here recommended is applicable to a complete report on a mining district, and a paper of different scope may well follow a similar general order so far as it can be applied to the facts presented. The titles of the headings may be modified according to the varying conditions in different regions and the taste of the author, but he should have some definite plan in mind before he begins to write. The general heads may comprise the following:

Preface.	Geography.
Outline of the report.	Geology.
Introduction.	Ore deposits.

PREFACE. The preface should be written and signed by the geologist in charge of the administrative unit to which the author belongs. It should indicate the character and purpose of the investigation and call atten-

tion to important features or results set forth in the report and to their bearing on regional or other broad problems.

OUTLINE OF THE REPORT. The author should write a brief but carefully prepared abstract of the report, with a view not only of giving the reader a preliminary survey of the work but of affording an authoritative outline for the press.

INTRODUCTION. The introduction may comprise a statement of the conditions under which the work was done, acknowledgment of favors, a summary of previous work in the same field, and a bibliography, if the literature on the district discussed is sufficient to warrant it. Bibliographies are more useful if the title of each paper is followed by a brief abstract of its contents.

GEOGRAPHY. The section on geography should describe location, routes of approach, topography, climate, vegetation, and other geographic features. Relief and drainage should be described as present features of the landscape, but their genesis and evolution should be discussed under 'Geology.'

GEOLOGY. The discussion of the geology should present general geologic information with regard to the region, in the following order: (a) The character and composition of different rock formations, in order of age, commencing with the oldest and distinguishing sedimentary from igneous; (b) the distribution and structural relations of the formations; (c) metamorphism; (d) the development of topographic features with special reference to lithology and geologic structure.

ORE DEPOSITS. The description of the ore deposits as a whole and the discussion of their genesis should form the principal part of the report. In this part the subdivisions suggested below may be enlarged or condensed according to the nature of the deposits, but the general order of subjects should be preserved.

(a) History of mining development. The author may relate the successive steps in the local progress of the mining art and state the present conditions. In some reports that are essentially economic this history may follow the 'Introduction.'

(b) Production. Annual and total output of mineral products, with sources of information.

(c) General character of deposits. Fissure veins, replacement deposits, contact deposits, etc.

(d) Mineralogy. Enumeration and brief description of gangue minerals, of original metallic minerals, in order of value of metal or other distinctive feature, and of secondary minerals or products of alteration, in the same order; also paragenesis or succession of minerals and its bearing on genesis.

(e) The deposits. Distribution and geologic features, structural relations, primary deposition, underground

*Prepared originally in 1906 by S. F. Emmons; revised in June 1913 and April 1916 by F. L. Ransome. From 'Suggestions to Authors of Papers for Publication by the United States Geological Survey,' by George McLane Wood, Editor.

water, secondary deposition and alteration of ore and country rock, distribution of ore in the deposits, age of original and secondary deposits, value of ores and its dependence on geologic conditions.

(f) Genesis of the deposits. The author should recapitulate the essential facts brought out in his descriptions, show their bearing on the problem of origin, and deduce such theoretical conclusions as they may warrant.

(g) Practical applications. The author may point out how his work may aid the miners in developing their orebodies or in finding new ones and may forecast, if possible, the economic future of the district.

(h) The mines. In the detailed descriptions of the individual mines or groups of mines the general order of treatment indicated above should be followed. It is well to select one or more of the principal or characteristic mines as types to be described in considerable detail.

DEFINITIONS

The following definitions of certain terms in common use are sanctioned by the practice of the Survey, and it is desirable to adhere to them in Survey reports, as a lack of uniformity in the use of such terms is likely to cause misunderstanding.

MATERIALS

ORE. Ore is a mineral or rock from which one or more metals may be profitably extracted. Material that cannot be profitably worked today may become of economic value a year or so hence without any change in character. Consequently, in using the term 'ore' it is necessary to take into account the effect of changing economic conditions and of probable improvements in metallurgical processes. According to the definition given above it is tautologic to use the term 'pay ore.'

GANGUE. The term 'gangue' is properly applied only to the earthy or non-metallic minerals that are of common occurrence in ore deposits, such as quartz, barite, chlorite, fluorite, calcite, and dolomite. The practice of describing as gangue any metallic minerals that may happen to be of no economic value is not desirable, even if they are called metallic gangue, for it permits no uniform distinction between ore and gangue.

In describing the minerals occurring in an ore deposit it is well to distinguish the exogenous gangue minerals—those that have been brought in from some outside source—from the endogenous gangue minerals—those that are the product of alteration of the wall rock or country rock.

VEIN MATERIAL. As a collective term to describe the aggregate materials which make up the orebody, the phrase 'vein material' or 'vein stuff' may be used. 'Vein stone' is a less desirable phrase, for the reason that 'stone' is used by some mining men as a technical term for ore, whereas others make 'vein stone' synonymous with 'gangue.'

GEOGUE. Gouge is a soft, clayey material that occurs in some places as a selvage between a vein and the country rock and is usually formed by the trituration of the

country rock by motion subsequent to the formation of the vein. The term should not be loosely used for any soft, crushed material.

COUNTRY ROCK. 'Country' is the miner's term for the rock which encloses an ore deposit. The term 'country rock' has been criticized as tautologic; nevertheless, it is sanctioned by very wide usage, and its use is considered advisable where the single word 'country' might lead to confusion in the mind of the non-technical reader.

FORMS

VEIN, LODE, VEIN SYSTEM. The material filling a fissure, when not injected as molten matter to form a dike, is termed a vein. Most veins are of nearly tabular form. An ore-bearing vein is a single body of metaliferous minerals occupying or following a fissure, both walls of which generally are well defined. Where several veins are so closely spaced that the ground between them becomes in places ore bearing and in its whole width constitutes an orebody, the assemblage is called a lode, although in legal phraseology lode or lead is in a broad sense synonymous with vein. The term 'vein system' may be used for a larger group of veins and may include several lodes. The fractures of the earth's crust that admit of ore deposition are so multiform that it is not possible to give stricter definitions. Usage may differ somewhat in different districts, but the general order from simpler to more complicated deposits will be vein, lode, vein system.

SHEAR ZONE. The term 'shear zone' denotes a section of the earth's crust within which the rocks have been closely laminated by yielding to a shearing stress. It is a structural feature along which ore may be deposited, but is not itself a form of deposit.

SHEETED ZONE. Where the country rock is traversed by approximately parallel fissures separated by thin sheets of rock it is said to be 'sheeted,' and the zone affected may be called a 'sheeted zone.' In a sheeted zone the fissures are generally more widely spaced and there is less crushing than in a shear zone.

FAULT. A fault, in its simplest form, is a fracture in the rock of the earth's crust accompanied by a displacement of one side with respect to the other in a direction parallel with the fracture. A fault is not a form of orebody, but, like shear zones and sheeted zones, it may influence ore deposition or determine the shape of a deposit. There has been much diversity in the nomenclature of faults, and authors are advised to follow the terminology recommended by a committee of the Geological Society of America.¹

BEDDED DEPOSIT, BED DEPOSIT. In contrast with veins, which cut across the bedding of the enclosing rocks, some deposits conform with the stratification. Such deposits are frequently called bedded deposits, but this name suggests that they were laid down as members

¹Reid, H. E., and others. Report of the Committee on the Nomenclature of Faults. Geol. Soc. American Bull., Vol. 24, pp. 163-186, 1913.

of the stratigraphic series in which they occur—that is, that they are syngenetic deposits. The term 'bed deposit' is of broader application; it will cover such deposits as may have been subsequently introduced between the beds—that is, epigenetic deposits.

GASH VEIN. The term 'gash vein' has been employed to describe a vein that fills joints or fissures in limestone in the lead deposits of the Mississippi Valley region. A gash vein does not extend beyond a single bed or similar rock mass.

TRUE VEIN. Whitney² used the expression 'true or fissure veins' in his tabular classification of ore deposits to distinguish from gash veins those veins which, according to him, "may be presumed to extend for an indefinite distance downward." Although in his text he uses the term 'true vein,' the expression he employs in his widely quoted table has probably given currency among miners to the term 'fissure vein' or even 'true fissure vein.' 'True vein' was the term in use before Whitney's table was published, and by the earlier writers on ore deposition it was employed to indicate an orebody that filled a fissure; hence the term 'fissure vein' is in a strict sense pleonastic and should not be used in classification.

STRUCTURE OF VEIN MATERIAL. The following forms of structure may be recognized in the material filling a fissure:

1. Banded structure, in which the vein shows in cross-section a banding nearly parallel to the wall. This may be subdivided, according to origin, into—

(a) Banded structure by filling, in which the filling is evidently a series of layers of vein material deposited successively on the walls of an open space. If the layers are symmetrically arranged on both sides of a medial plane, with crystals pointing inward, comb structure is produced. In the middle part of the vein there may be cavities or vugs lined with crystals.

(b) Banded structure by subsequent movement, or ribbon structure, produced by a simple sheeting of the vein material after original deposition. Such movement may result in a reopening along the new plane of movement and the deposition of new material in the opening.

(c) Banded structure by replacement, produced where the original fissure consisted of a number of parallel openings separated by thin bands of country rock and where, during or subsequent to the filling of these openings, the intervening bands of country rock have been more or less extensively replaced by vein material.

2. Breccia structure, in which the friable breccia or dragged-in fragments of country rock constitute a considerable part of the vein filling and the ore has been deposited in the spaces between the fragments, perhaps in more or less concentric shells or layers around them. Breccia structure may occur in any vein, hence it is not desirable to use 'brecciated vein' as a term of classification.

LINKED VEINS. Deposits that fill approximately parallel and over-lapping fissures, arranged in step-like form and connected or linked by small, irregular cross-stringers, are called linked veins. As the deposit pinches out on one fissure it is taken up on one of the over-lapping fissures.

STRINGER LOBE. A stringer lobe is made up of irregularly branching and anastomosing stringers or veinlets. In most stringer lobes the rock between the veinlets is so much metallized or is so inseparable from the stringers that the whole is worked as a single orebody.

CHIMNEY, STOCK. The term 'chimney' is applied to orebodies that have not the tabular form of a vein, but are rudely circular or elliptical in outline horizontally and have a very considerable vertical extent. A similar body of still greater irregularity of outline is called a stock.

STOCKWORK. A stockwork is an orebody of stocklike form made up of innumerable branching and anastomosing stringers.

ORE-SHOOT, PAY-SHOOT. An ore-shoot or pay-shoot is that part of a metalliferous deposit which is rich enough to exploit. Its outlines are not generally well defined. The ore-shoot may be considered as having three axes, at right angles to one another. The inclination of the longest axis to a horizontal plane is called the plunge and is measured in a vertical plane erected along the axis. The angle made by this axis with a horizontal line, measured in the plane of the vein, is called the pitch. In an ore-shoot that is part of a vein the dip of the vein and the plunge of the ore-shoot coincide when the pitch is 90°.

The true dimensions of an ore-shoot would be shown by giving the length of its longest axis and the area of one or more cross-sections normal to that axis. Inasmuch, however, as its true form can rarely be determined until all the ore has been mined, it is common practice to speak of its length and width or thickness as those of a horizontal section of the body on a given level of the mine. These are evidently not true dimensions unless the longest axis of the body is vertical. It is advisable to follow the usage adopted by Lindgren and Ransome in their Cripple Creek report and call the longest axis 'pitch length' and the horizontal dimension along the level 'stope length.'

CONTACT DEPOSITS. The term 'contact deposits' should be restricted to deposits which have been formed by igneous metamorphism and which carry the mineral characteristic of such action. Such use eliminates from this category many forms of deposit that have been so termed simply because they happen to occur between rocks of two different kinds. Contact deposits, as thus defined, occur mostly in limestone at or near its contact with an intrusive igneous rock. They are very irregular in form. Mineralogically they differ from other deposits by the contemporaneous formation of oxides and sulphides, principally of iron, and by the association of these oxides and sulphides with silicate minerals.

²Whitney, J. D. 'The Metallic Wealth of the United States Described and Compared with that of other Countries,' pp. 34, 49, 1854.

SEGREGATED VEIN. The term 'segregated vein' has sometimes been used to define materials that have been concentrated in a sedimentary bed. As a general rule, however, the name of a process should not be used as the definition of a type of deposit, and 'segregation' is more appropriately applied to the gathering together of material in a molten magma. In either sense reference to a deposit as 'segregated' does not sufficiently characterize it as a type.

IMPREGNATION. The term 'impregnation' has been used by different writers in many and conflicting senses. It properly signifies the introduction of mineral substances in a finely disseminated condition into rocks, either as a filling of open spaces or as a replacement of certain minerals. To describe ore occurring in small, irregular, disconnected particles throughout the mass of rock, 'disseminated deposits' is a preferable term, for it has no genetic signification.

PROCESSES

METASOMATISM. Metasomatism may be defined as the process by which, through chemical interchange, a mineral or an aggregate of minerals undergoes partial or complete change in chemical constitution. The term 'metasomatism' is of wider application than 'pseudomorphism,' for the process it designates does not necessarily involve the preservation of the crystalline form of the original mineral. It may or may not be accompanied by a change in volume.

REPLACEMENT. As a general term synonymous with 'metasomatism,' 'replacement' is preferable to 'substitution,' which is a chemical term strictly defined as "the replacing of one or more elements or radicals in a compound by other elements or compounds," a restricted usage to which 'replacement' is not confined. Replacement may be either partial or complete, according as only a part or the whole of one rock or mineral has been replaced by another.

ALTERATION. The term 'alteration' applies to the partial change of substance in a rock or mineral which does not necessarily involve its replacement by another. The process is purely chemical.

DECOMPOSITION. The term 'decomposition' signifies the decay of a rock or mineral into secondary products, usually accompanied by disintegration, so that it involves a physical as well as a chemical change and is most commonly effected by weathering.

WEATHERING. The term 'weathering' should be confined to changes in cohesion and composition of rocks near the surface by the decomposing and oxidizing action of surface waters, by variations in temperature, and by other atmospheric and surface agencies. The tendency of such changes is to destroy the rock as a geologic unit.

ENRICHMENT. In many sulphide deposits the valuable metals have been concentrated by solutions that have descended from the zone of oxidation. As commonly used the expression 'secondary enrichment,' although having some justification as an elliptic phrase, is

tautologic in form and should be avoided. The idea which this term is intended to convey may be expressed by 'enrichment,' 'secondary segregation,' 'downward enrichment,' or 'supergene enrichment,' according to choice or circumstances.

MIXING TERMS

In describing a mine it is well to state concisely the extent and character of the mine openings, for which the terms in general use, given in the following paragraphs, should be employed. If a local term, not in general use, is employed its meaning should be stated.

SHAFT, INCLINE, SLOPE, WINZE, RAISE, CHUTE, STOPE. The term 'shaft,' if not qualified, means a vertical opening starting at the surface. A shaft that follows the inclination of a vein or bed that is not vertical is called an inclined shaft, or simply an incline. In coal mines such an incline is commonly termed a slope. Passages within a mine driven upward from a horizontal gallery are called raises or upraises; those driven downward are called winzes. Inclined raises or winzes are often termed inclines. If used for sending ore down from a higher to a lower part of the mine such passages are termed chutes, ore chutes, or mill holes. A stope is an opening made in extracting ore.

TUNNEL, ADIT, DRIFT, CROSS-CUT, LEVEL. Properly defined, a tunnel is an underground gallery open to the air at both ends, an adit is open at only one end, and drifts and cross-cuts are horizontal galleries that do not reach the surface. In the United States, however, the term 'tunnel' has come into use among miners in a sense more or less synonymous with 'adit' and in this sense it is recognized by the mining law; hence it cannot be confined to its original meaning.

The following distinctions are made by miners and may well be observed in writing: A drift follows the general strike of an orebody, vein, or rock structure. A crosscut, as its name implies, crosses the trend of the ore or rock structure. Stations are roomlike enlargements of drifts or cross-cuts where they connect with a shaft. All the drifts and cross-cuts that connect on approximately the same horizontal plane with a station or with an adit constitute a level. If the level opens to the surface through an adit it is termed an adit level.

DIP, PITCH. Dip is the angular divergence of a bed or of a tabular deposit, such as a vein, from a horizontal plane. The term 'pitch,' originally used to signify the inclination of the axis of a fold from a horizontal line, has come into use among miners to express the inclination of the longest axis of an orebody or pay shoot within the plane of the vein. It should not be confounded with dip.

MINE, PROSPECT. It may be difficult to decide whether a certain property shall be called a mine or a prospect, and no hard and fast rule can be laid down for universal application. In general, shafts that are less than 100 feet in depth, with less than 100 feet of drifting, and that have not produced ore in commercial quantity should be termed prospects.

Cobalt, Ontario

Products, Supplies, and Power

The Dominion Royal Commission recently investigated conditions at Cobalt, and according to *The Northern Miner* the following notes are part of a memorandum presented to the tribunal:

Silver was discovered at Cobalt in 1903, but it was not until the following year that shipments commenced. The valuable metals contained in the ores are silver, cobalt, nickel, and arsenic. In most cases only the silver is paid for by the smelters, the other metals being saved by them as by-products enabling them to give better rates on the silver. In the early years of Cobalt all ore shipments had to go out of the country for treatment, most of it to the United States. Canadian smelters were soon started to treat high-grade ore. The latest development has been the operation of the so-called high-grade mills at Cobalt, which produce silver bullion by a combination amalgamation-cyanide process. An examination of the figures for the calendar years 1914 and 1915 shows that the percentage of silver bullion produced from Cobalt ores was in round numbers:

	1914	1915
	%	%
Cobalt mills, amalgamation and cyanidation.....	44	39
Southern Ontario smelters	39	45
United States smelters	17	16
Total	100	100

The quantity still going to the United States consists of some high-grade ore along with all the low-grade material, both ore and concentrates shipped, as the Canadian smelters are not equipped to reduce this. In the high-grade mills at Cobalt the silver only is recovered, the cobalt, nickel and arsenic being left in the residue for future treatment or sold for the cobalt-content. The Deloro and Coniagas smelters are equipped with complete refineries so that besides producing silver bullion they also produce and market arsenic, cobalt, and nickel. The cobalt and nickel have been produced mostly as oxides, but as there has recently been a market for the metals they are now also produced in that form.

The gross value of the silver ore shipments for 1915 to the mining companies was \$11,703,966; deduct dividends paid in 1915 \$4,523,414, and the cost will be \$7,180,552.

On the assumption that cash surpluses remained the same at the end of the year as at the beginning, it thus costs \$7,000,000 to operate the mines of Cobalt for one year. Of this amount it may be assumed that 40% was paid for supplies, or \$2,800,000. Some of the supplies used are given herewith showing quantity, value, and origin:

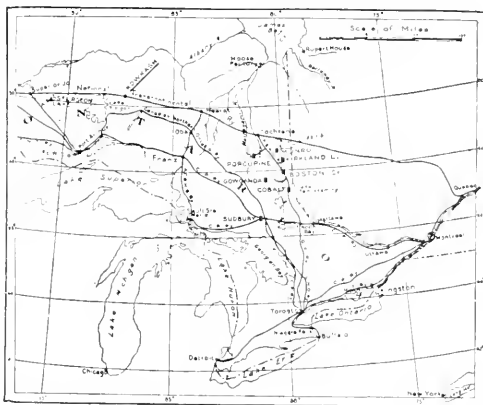
Cobalt and Porcupine combined use \$574,000 of cyanide per annum. Of this \$400,000 comes from the Cassel Cyanide Co. of Glasgow, and the remainder has been supplied by a German firm in the United States. From now on it is probable that all will be supplied by the Cassel company.

Cobalt and Porcupine use \$40,000 of pebbles per annum; all imported from Europe, mostly from France. Newfoundland had part of this market but lost it through shipments of poor material.

Cobalt and Porcupine use 200 tons of zinc, valued at \$80,000. This mostly comes from Japan at present, but soon it will be supplied from the United States.

Cobalt uses 900 tons of powder per annum, valued at \$450,000, while Porcupine takes an additional 1650 tons, and other smaller centres 80 tons more. All this is manufactured in Canada.

Cobalt uses 3,700,000 ft. of fuse per annum, valued at



MAP SHOWING PRINCIPAL MINING DISTRICTS OF ONTARIO.

\$17,000. Porcupine takes 7,000,000 ft. Of this 56% is British and 44% of United States manufacture. No fuse is made in Canada.

Cobalt uses 740,000 detonators valued at \$22,200. They are now manufactured at Brownsburg, Canada.

Drill-steel for Cobalt and Porcupine costs \$80,000. Formerly this was supplied equally by England and United States, but now England cannot supply it.

Lubricating oils, etc., \$40,000 per annum for Cobalt and Porcupine. All are American oils, but 30% is refined in Canada.

Power developments in the vicinity of Cobalt are as follows:

Hydraulic air-compressor plant at Ragged Chutes on the Montreal river has a capacity of about 5000 hp. of compressed air. The air is transmitted in pipes approximately 9 miles to the mines in the district. The main distributing system consists of 20-in. steel pipes with secondary and service lines of from 12 in. to pipes of smaller diameter.

Hydro-electric plant No. 1 is at Hound Chutes on the Montreal river 6 miles south of Cobalt, with a capacity of 4500 hp. Equipment consists of four 750-kw. generators, operating under a nominal head of 33 ft. Power is generated at 11,000 volts, and transmitted over pole-lines to Cobalt and vicinity.

Hydro-electric plant No. 2 is at Fountain Falls 4 miles below Hound Chutes. Two 1500-hp. vertical I. P.

Morris turbines direct-connected to two 1250-kw., 11,000-volt generators, operating under a nominal head of 30 ft., running in parallel with Hound Chutes and Matabitchouan generating stations.

Hydro-electric plant No. 3 on the Matabitchouan river, is 25 miles south-east of Cobalt. Equipment consists of four 1875-kw. generating units, operating under a nominal head of 312 ft. with a total capacity of 10,000 hp., at 44,000 volts. The transmission-lines consist of two circuits on separate poles extending from the powerhouse to South Lorrain and Cobalt, also operating in parallel with Hound Chutes and Fountain Falls plants.

The capacity and average power demand of various plants are as follows:

Station	Capacity horse-power	Present demand horse-power
Matabitchouan	10,000	9,000
Hound Chutes	4,500	4,000
Fountain Falls	3,300	shut-down
Ragged Chutes (air)	5,500	full load

The territory served embraces the Cobalt mining district where the company sells the bulk of its power at \$50 per hp.-year. The present demand for power is increasing owing to the higher price of silver, which has resulted in the opening of smaller mines and a more vigorous development on the part of the older mines. Also as a result of the improved methods the mines are enabled to treat their dumps and lower-grade ores. In order to find a market for the surplus power which is anticipated in consequence of mine exhaustion, there is now being constructed a transmission-line 65 miles north to the Kirkland Lake gold-field. As soon as completed this may give an additional 2000 or 3000-hp. load. This line will be designed to ultimately transit 5000 hp. The principal undeveloped water power now available is near the head of Lake Timiskaming on the Des Quinze or Ottawa river, 25 miles north-east of Cobalt. There have been several estimates made of the power, nominally amounting to about 150,000 hp. At the present time there is no market for such a development, although it is understood that a large pulp company contemplates getting power from this source.

Gold Output of the Rand for Half-Year

The total output to June 30, 1916, was as follows:

Waste sorted out, per cent	9.17
One treated, tons	14,171,862
Yield per ton	\$6.48
Working cost per ton	1.38
Total profit (95771,850)	\$27,850,000

Compared with the whole of 1915 when 28,311,579 tons averaged \$6.30 per ton, costs \$118.70, total profit of \$57,600,000 the current year shows an increased yield on a trifle less tonnage, with 20% extra cost and nearly the same profit, 2% per ton more.

Ordered orders on the U. S. Steel Corporation's books total 9,660,457 tons.

Acetylene v. Candles

By Warren G. Lenhart

With the use of acetylene, which tends to make the working-man safer and more efficient, there comes much criticism against the new and untried article, without first weighing its merits. The acetylene, or carbide lamp, when it comes to efficiency, is undoubtedly far superior to the candle. It gives a light more like the sun than any other medium. It is safer, cheaper, and allows both hands to do the work where formerly one hand had to be employed holding the candle. It holds-up its light in a draft in raise or drift. Taking safety as a basis for estimating its merits, it equals, if not surpasses, the candle. The latter at its best is a feeble light, and vitiates the atmosphere by taking-up the contained oxygen. Air in mines does not contain enough oxygen as it is, and by using a light that takes less than before, the men breathing such an atmosphere are benefited. The gas evolved through leakage is nil, and it would take 20% by volume to make the air polluted to such an extent as to make a man unconscious. The residue left in the bottom of the lamp is a disinfectant, being calcium oxide or lime, and is a good purgative when properly used. As superintendents and shift-bosses have good lights with which to inspect the miners' work, why not give the latter the same light to do their work.

This was written by an employee of the Anaconda company's Belmont mine, and the editor of *The Anode* added the following: Several hundreds of carbide lamps have been purchased for use in the company's mines, and it is expected that eventually they will entirely replace the use of candles. We are glad to publish these comments on the respective merits of carbide lamps and candles, and hope that they will remove any prejudices that may exist. The Bureau of Safety does not, however, recommend the use of spent carbide as a purgative. —*The Anode*.

PERHAPS the most marked feature in the history of power production has been the replacing of reciprocating machinery by that of rotary type. The steam turbine has invaded and captured a considerable portion of the fields of usefulness of the reciprocating steam engine. The centrifugal water-pump has replaced the reciprocating pump; rotary condenser auxiliaries are rapidly superseding reciprocating plant, and rotary air blowers and compressors have entered into successful contest with reciprocating compressors. The principal factors which have decided the issue in favor of the rotary plant are: small space, excellent balance, and low first cost and maintenance. In the case of the steam turbine there is the important additional advantage of using steam which otherwise would be wasted.—*Compressed Air Magazine*.

Iron ore imported during June were 134,151 tons. Ore is imported from Canada, Cuba, Spain, and Sweden. Exports in June were 204,558 tons.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

POWER CONSUMED by the Conrey dredges in Montana varies from 1.36 to 1.89 kw.-hr. per cubic yard of ground dug.

DOUBLING the diameter of a pipe increases its capacity four times. Friction increases as the square of the velocity.

FLOTATION of Mount Morgan gold-copper ore costs 34c. per ton of ore treated. Ten cents of this is for eucalyptus oil and residuum.

THE HEAVIEST SUBSTANCE known is osmium, which has nearly twice the weight of lead. The specific gravity of gold is about $19\frac{1}{4}$, while that of osmium is nearly $22\frac{1}{2}$.

OXYGEN in the oxy-acetylene jet ceases to cut when 16% of nitrogen is present. The cutting efficiency is directly proportionate to the percentage of nitrogen under 16%.

THE 'STANDARD CANDLE' is made of spermaceti, and burns 120 grains of spermaceti per hour. It serves as a standard for calibrating the intensity of electric and other lights.

GASOLINE HOISTS are frequently used underground in confined spaces, and miners would be wise to be careful, as fatal explosions have occurred when a dangerous mixture of gas and air is formed in such places.

OF 17,500 TONS OF COPPER produced in the United States during 1874, the Calumet & Hecla produced 87%. This was before the producing days of the great copper mines of the West, which began about 1883.

DANGER in handling calcium carbide in a mine is remote if reasonable care is observed with its use. The smallest proportion of acetylene capable of propagating flame in a mixture of acetylene and air is 2.53%; the largest proportion, 73%.

BLACK POWDER is still extensively used for blasting and mining purposes, but has lost its importance as a propellant in modern firearms, although still retained for blasting and other special purposes supplemental to the more important smokeless powder.

ALL ROCKS contain some water; but some, such as the granites, contain only an inappreciable amount. Sandstone, on the other hand, has an absorptive capacity of a gallon or more of water per cubic foot of rock, and is the best water-bearer of the solid rocks.

AIR-DRILL hose is often affected unfavorably by miners

pouring oil in the hose itself before connecting to the drill-machines. This saves them the labor of unscrewing the oil-plugs of the drill and replacing them. The oil may be good for the drill but surely is bad for the hose.

DESERT counties of California furnish the larger variety of minerals due to the climatic conditions that have prevailed there. Not only are the minerals found typical of mountainous regions, but in addition, they are typical of the dry plains and former marshes and lakes, such as the borates, sulphates, carbonates, nitrates, and chlorides.

LAST YEAR the Argonaut mine, the chief producer on the Mother Lode, California, produced gold worth \$775,928, from which a profit of \$447,317 was earned. The ore yielded \$9,268 in bullion, \$1,671 in concentrate, and 13.9c. in slime, so that the total yield was \$11,078. Therefore the cost was \$4.538 per ton. Construction expense was 35.5c. per ton.

SELECTIVE FLOTATION at the lead section of the Broken Hill South slime plant is giving satisfactory results, one week's run at the end of July showing the following: The feed averaged 10.5% lead, 7.4 oz. silver, and 12.3% zinc. This yielded concentrate assaying 61.8% lead, 45.4 oz. silver, and 10.6% zinc. The recovery was 88% lead, 90.9% silver, and 12.9% zinc.

CAUSE of the collapse of the bridge over the St. Lawrence river in Quebec on September 11 is ascribed to the failure of a cast-steel shoe upon which rested the south up-stream corner of the span being lifted into place. This shoe carried 1300 tons, one-quarter of the total weight of the span, and was part of one of the four lifting girders, one being at each corner of the span, and hanging from the ends of the cantilever sections of the bridge from each shore. The shoe should have been a forging. The whole span was of nickel-steel.

WAGES AND HOURS at Broken Hill, Australia, were adjusted by the Federal Arbitration Court in June as follows: an increase of 42 cents per day as compared with the rates under the previous agreement between the mine-owners and employees; overtime was increased from time and a quarter to time and a half and to double time, for ordinary days and Sundays and holidays, respectively; Sundays and holidays where continuous process is worked get a raise from time and a quarter to time and a half; underground men were allotted a 44-hour week, to be paid the same as if the former 48 hours were worked. Surface employees get a 16.6% increase, underground men 24.3%, and all employees 21.9%. The Broken Hill South company, which employs 400 on the surface and 875 in the mine, will have its expenses increased by a total of \$221,000 per year. Nearly all work in this mine is done on contract. During the half-year ended June 30, 1916, miners averaged \$4.12, and trammers \$3.42 per 8-hour shift.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

BUTTE, MONTANA

COMPENSATION IN MONTANA.—NEW HOIST AT BUTTE & SUPERIOR.
—NORTH BUTTE'S NEW MINING AND TREATMENT TESTS.—
ELECTROLYTIC ZINC.

The report of the State Industrial Accident Board shows that during the year ended June 30, 1916, there were 136 fatalities, 3 permanent total, 89 permanent part, and 6576 temporary disabilities. Of the last mentioned 1131 received compensation and 5145 returned to work within two weeks, and were therefore only entitled to medical and hospital attendance. It has been said that

"It is safe to say that under the old liability system not over 10% of the victims of these accidents would have had any standing in court; and if that number were able to reach a hearing before a judicial tribunal not more than one-fourth would secure a verdict, which would reduce the number recovering anything to a possible 4%. Computed on the ratio of average verdicts that have been secured in the industrial field in Montana on account of personal injuries, this would indicate a recovery of less than \$60,000, against the \$288,506 that has been paid out under the compensation system. Yet it is doubtful if the cost to the employers in paying out this enormous sum for compensation has exceeded the cost that would have incurred under the old system, with its heavy court cost and expensive army of high-priced attorneys."

The figures show that the cost of liability is between \$1000 and \$1100 per day. This is regarded as exceedingly low, and is attributed to the fact that the employers and employees are engaged in active rivalry to surpass in the safety-first propaganda. Cash prizes are offered to foremen and superintendents at mines, mills, smelters, and industrial plants, for the best records covering accident prevention. Aside from the humanitarian features involved, accidents now cost a certain amount of money and represent a fixed factor of expense. The man in charge of operation, as well as the men under him, is now held to a strict accounting for results in that line, as was formerly the case covering the amount of ground broken or the number of tons of ore extracted. There are 1518 employers actively operating under the act, which is about 98% of the employers engaged in hazardous industries who employ five men or more. The report shows that there are about 60,000 workmen who come under the act, that 17% were injured sufficiently to draw compensation, and 1% of the men killed had no beneficiaries, consequently no claims for compensation were filed.

The Butte & Superior's new hoist is designed to haul ore from a depth of 3000 ft. The 1800-ft. level is the lowest now being worked, so the hoist will fulfill all requirements for some years to come. The drums will be 9 ft. in diam. by 12 ft. face, and will wind the rope in two layers. The rope speed will be 2250 ft. per minute, and the maximum rope pull 4,000 lb. The hoist will be driven with a 100-hp. direct-current motor, receiving its energy from a fly-wheel generator set. The drums are so constructed that after reaching the 3000-ft. point new drum shells can be fitted, converting the drum into 12 ft. diam. by 10 ft. face, after which the rope will wind 5000 ft. of rope in two layers with a maximum rope pull of 52,000 lb. and speed of 3000 ft. per minute. When the change is made, and the 12 ft. drums are in use, a second 150-hp. motor will be installed on the other end of the drum shaft, and the fly-wheel set will be doubled. Control of the

hoists will be the Westinghouse standard type for limiting the acceleration and retardation. It will be operated by cams directly driven through gearing from each drum. A Welch safety-stop will also be fitted on, and it will take control when the electrical equipment fails and when no power is in use.

North Butte will develop part of its holdings in the eastern part of the district by a 2000-ft. adit that will soon be started on the Northwestern claim in Park canyon. The company owns 700 acres in this section. Part of it adjoins the Butte-Duluth, now being operated by the Frank interests of Salt Lake City. A large quantity of copper-carbonate ore is exposed at the surface on this property, but there has been no extensive development at depth. The Bertha claim of the North Butte adjoins the Bullwhacker, where silicate and oxide ores are being mined from open-cuts and where a vein carrying sulphide ore was recently cut at a depth of 100 ft. At another place the company's holdings touch the boundary line of the Butte Main Range, which is mining a narrow vein of 9% copper ore on its 500-ft. level. A compressor is being installed at the mouth of the new adit, and plans are being made to insure an average advance of 400 ft. per month. The adit will penetrate the foot-hills of the continental divide, and will cut the veins at a depth of 500 ft. This work is of a preliminary nature, and the information disclosed as to the situation, dip, and strike of the veins will be useful in determining the site for a shaft through which the property will be explored at depth. Conditions are favorable for the development of a large tonnage of silicate and oxide ores near the surface. At the present price of copper these ores could be shipped direct to a smelter. It is also probable that a method of concentrating will be devised. At present experiments are being made in coating the copper minerals with a film of sulphide, and then treating them by flotation. It is claimed that the tests have given good results, and that the silicates are successfully floated in the laboratory. The new development is two miles east of the Speculator and Granite Mountain shafts through which the whole of the present production is being hoisted.

Anaconda's new zinc plant at Great Falls made its first electrolytic zinc on September 11. Some of the aluminum cathodes were raised and stripped of their thin coating of zinc a few hours after the solution had been turned into the electrolytic tanks. The thin zinc sheet was quickly cut up into souvenirs. The plant has a capacity of 5,000,000 lb. of refined zinc per month, and all the units are expected to be in operation by November 1. The ore is mined at Butte, concentrated at Anaconda, and leached at Great Falls. The concentrates are roasted to change the zinc sulphide to a sulphate. The calcines are treated with sulphuric acid in 20 tanks, each 10 ft. diam. and 20 ft. deep. Compressed air is used for agitating, and the pulp then flows to Dorr thickeners. There are six of these 50 ft. diam. and 15 ft. deep. The overflow, after being filtered, goes to the electrolytic tanks, while the solution is taken from the thickened pulp by 12 Oliver filters. There are 720 electrolytic tanks 11 ft. long, 3 ft. wide, and 5 ft. deep. Each tank contains 281 of anodes and 27 aluminum cathodes. After the zinc is re-deposited, the solution is pumped back to the leaching tank. The electric power comes from the Big Falls and Rainbow hydroelectric plants situated a short distance down the river from Great Falls. The current is changed from alternating to direct by five rotary converters. It is expected that some ore will be shipped from the Douglas property in the Comstock district of Idaho to this plant.

TORONTO, ONTARIO

COBALT LABOR INVESTIGATION.—FLOTATION.—NICKEL REFINERY.

The Royal Commission appointed to investigate the labor difficulties at Cobalt has been in session and will shortly report. It appears that the principal difference was concerning the bonus of 25c. per day, which the miners were to receive during months when the price of silver averaged over 70c. per oz. They received this for one month, but when the price dropped the bonus ceased. The men object to their pay being regulated by the price of the product. Owing to enlistments and the high wages offered to laborers in munition factories there is a marked shortage of labor in all the mining centres, which, while it has not so far seriously affected normal production, tends to prevent the expansion of the mining industry.

The large flotation annex at the Coniagas has been started. It has a capacity of 600 tons per day, and will treat 100 tons from the mine and 500 tons of tailing from the dump. It is estimated that the accumulations of tailings for the last seven years amount to 300,000 tons, containing 1,000,000 oz. of silver.

The shaft being put down jointly by the Ophir and Peoples companies has reached a depth of 415 ft., just below the contact, where a station will be cut and exploration commenced by cross-cutting.—The Calumet & Montana Consolidated has blocked out a large tonnage on two levels, a considerable proportion of which is high grade.

It is apparently finally settled that the nickel refineries to be established by the International Nickel Co. and the British Canadian Co. will be in southern Ontario, somewhere near Lake Erie or Lake Ontario. Representatives of both companies have examined a large number of proposed sites, but are understood to have decided against construction in the northern mining districts on account of the severity of the climate during the winter. Favorable terms were offered by the city of Ottawa, but this, although considerably south of the mining centres, was regarded as too far north.

The INTERNATIONAL NICKEL Co. of New York announces that arrangements have been made for the construction of its new refinery to be built at Port Colborne, Ontario. The work will be carried out by The Foundation Company, Limited, of Montreal and New York.

SUTTER CREEK, CALIFORNIA

NOTES ON THE STRIKE SITUATION.—CENTRAL EUREKA IN AUGUST.

—SHAFT WORK AT THE PLYMOUTH AND BUNKER HILL.—
HARDENBERG MINE.

The following was written on September 19:

Later developments in the strike situation are that the miners held a mass meeting on the 19th at Italian Society park, between Sutter Creek and Jackson, gathering from all parts of the mining region in Amador county. Afterwards several hundred men paraded the streets, first at Jackson and then here, carrying flags and chanting Italian and Slavonian songs. The Sheriff had appointed and had sworn in a number of deputies. The South Eureka company has had several of its trusted employees provided with badges, not that violence is threatened but to be on the safe side. Contrary to first report, the three mines that have been paying their men the \$3.50 and \$3 demanded, are still running, namely, the Old Eureka, Keystone, and Original Amador. The other mines have simply retained their engineers, pump-men, and shaft-men, but the mine-owners' threat is to shut-down everything if the men persist in their demands for a 25-cent increase, and to have their time begin and end at the collar of the shaft. As it is now, in the more thoroughly developed mines, men claim that they lose from 15 to 90 minutes per day in getting to and from the working faces to the shaft-collar, partly due to the dis-

tance to be traveled in reaching the shaft and partly in waiting their turn on the skip.

The Kennedy, Argonaut, Bunker Hill, and Plymouth mines are the only dividend-payers along the Lode in this county; others are said to be barely keeping even, such as the Keystone, South Eureka, and Fremont; while the Treasure and Central Eureka are working on assessments, so there may be some justice in the mine-owners' claim that they cannot meet the men's demands at the present time. Little work is being done at the Original Amador. At the Old Eureka work is confined to unwatering and re-timbering the shaft and making surface improvements, so there are probably not over 100 men now engaged in actual mining, and there are said to be 1200 men out on this strike.

The Central Eureka company, whose mine is at Sutter Creek, has just issued the following report covering operations during August. The 2646 tons of ore crushed yielded an average of \$3.38 per ton. Earnings included \$4889 from 289 oz. of bullion, \$4040 from 56 tons of concentrate, and \$134 from sundries, a total of \$9063. Expenses included mining, pumping, and shaft repairs, \$9178; milling, \$1063; tailing-dam, \$518; sundries, \$1943; and indemnity insurance, \$405, a total of \$13,367. During the month 223 ft. of driving and raising was done, and a good deal of work in the shaft preparatory to sinking. There remained in the treasury on September 1 \$8596 from the last assessment levied, and when the shaft is put down for one or two new levels below 3200 ft., there is reason to believe that the property can be profitably operated. Fred Jost is superintendent.

Shaft repairs are in progress at the Plymouth Consolidated, as well as installation of the new electric hoist, which will be ready for operation by October 1. While similar to the machinery at the South Eureka mine, this hoist is much larger and is equipped with the latest improvements. The drum is 9 ft. diam., and the plant has a hoisting capacity of 1000 ft. per minute. By means of coarse crushing and re-grinding in Hardinge mills the 30 stamps reduced over 340 tons per day during August.

Reinforced concrete has been used at the Bunker Hill mine near Amador City to wall the shaft to a point 225 ft. below the collar, a new departure in Mother Lode practice. Square timbers, 14 by 14 in., and larger, are commonly used, the initial expense of concrete work being in most instances prohibitive here. However, as the shaft-sets, especially those near the surface, have to be frequently renewed, this will prove a saving in the end, particularly where the ground is loose and inclined to collapse. Only a few years ago a cave-in closed the upper portion of the Bunker Hill shaft and the men escaped through an adit or drainage-tunnel. Concrete ore-bins are also being constructed at the collar of the shaft so as to do away with the frequent re-building of the wooden structures. Good progress is being made with the installation of concentrators and rolls at the mill. The Bunker Hill mine is listed among Amador County's dividend payers, not having missed a single monthly dividend of 2½c. or more for nearly nine years. E. Hampton is superintendent and R. Christiansen foreman. Nearly all the men were laid off at the Bunker Hill mine prior to the strike, so that the shaft and surface improvements could be made without interruption.

W. J. Loring, who secured money to finance the Plymouth Consolidated, and who is interested in other properties along the Lode, has recently secured a three-months' option on the Hardenberg mine on the Mokelumne river in this county, 3½ miles south of Jackson. The Hardenberg has a 20-stamp mill, a three-compartment shaft over 1000 ft. deep, and is considered a valuable property. It extends 2300 ft. on the Lode, and has yielded good ore from a 6-ft. vein. Mrs. Kate N. Wells of San Francisco is one of the principal owners.

Up to going to press on the 26th there were no new developments in the strike situation. As reported on another page, the Plymouth mine is again in operation. There has been a little gun-play at Sutter Creek, but nothing serious.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

JEROME. Extensive work is contemplated for the Green Monster property. Two shafts are to be sunk 150 ft. on promising outcrops. The old Gorge adit on the Cliff claim has been put in order for 800 ft., and is to be extended 150 ft. to the contact. The Revenue adit is also being driven, with two cross-cuts. Camp buildings are being erected. A 6000-ft. pipeline has been laid. Electric machinery is arriving. Over 30 men are employed.

In the September Bulletin of the A. I. M. E., mine-fire

OATMAN. The U. S. Geological Survey, in charge of L. F. Biggs, is doing preliminary work for examination of this district.

On the 400-ft. level of Aztec shaft, 600 ft. east of the Big Jim end-line, the Tom Reed company has cut 18 ft. of good ore. Shares rose from \$1.59 to \$2.10.

The Golconda has let a contract for sinking its shaft 425 ft. The formation in this mine is andesite.

TUCSON. The Arizona State Bureau of Mines has received many requests from the East from people desiring to purchase

or lease talc and soapstone properties within this State. Although there are undoubtedly deposits of this mineral in Arizona, there are no records of any. To be commercial, a deposit of talc must be close to a railroad, although talc in extra pure form, such as may be worked for crayons, pencils, etc., brings as high as \$100 per ton. Soapstone is usually quarried, and while it does not bring high prices, it is easily mined and handled. The Bureau would be pleased to learn of deposits of this character.

ARKANSAS

YELLYVILLE. The Batty zinc mine, 8 miles north, has been sold to Senator Killiam and others of Locust Grove, Oklahoma, for \$20,000. New Jersey people held the property for some years, but did little work on it.

CALIFORNIA

The sequence of events during the strike along the Mother Lode since Tuesday, the 19th, is as follows:

The Mine, Mill, and Smelter Workers' Union issued the following statement:

"To the Workingmen of Amador County: The 25-cent increase in the daily wages asked by the miners has been refused by the mine operators, and all workers are requested to stay at home until the increase asked is granted. This is signed by the strike committee. All members of the Miners' Union are requested to meet in front of the Moose hall in Jackson at 1 o'clock, Wednesday afternoon, for a discussion of matters pertaining to the situation."

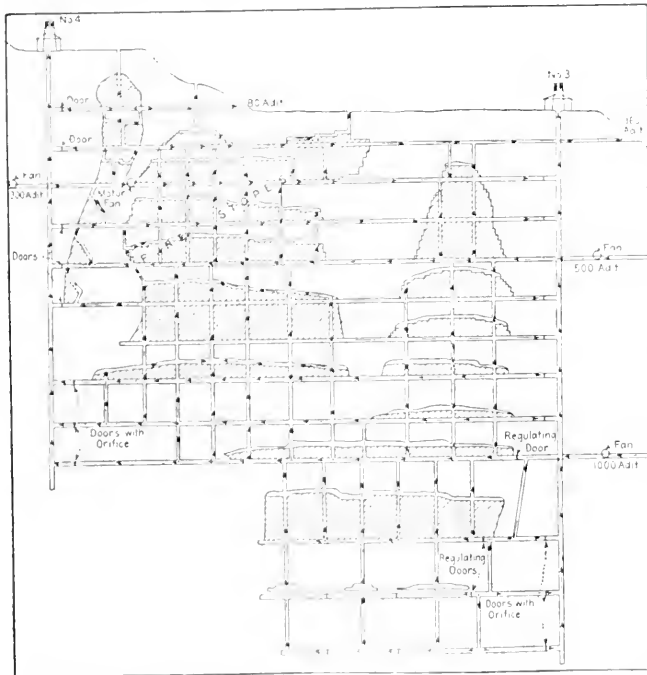
This affected about 1500 men, 800 of whom are unionists. About 400 men employed at the Old Eureka, Keystone, and Original Amador are working, as these companies raised wages some time ago.

The strikers are quiet and orderly.

For the first time in 30 years the Kennedy mine whistle failed to blow on the 19th. James Gianbruni, secretary of the Union in Amador county, cautioned the men not to use violence, and that they were willing to arbitrate the wage question.

Pumping is being done where necessary.

A parade of strikers was held at Amador City on the 21st, starting at Jackson and passing through Sutter Creek. Many banners were carried. It was expected that Western Federal



VERTICAL SECTION OF UNITED VERDE MINE AT JEROME, SHOWING SYSTEM OF VENTILATION.

methods employed by the United Verde Copper Co. are described by Robert E. Tally. The Plenum system is used, in which air of greater pressure than the gas from fires is forced into the fire-area.

MIAMI. The Inspiration is treating between 16,000 and 17,000 tons of ore daily. On No. 6 level a loco repair shop is being constructed. The reinforced concrete construction at shaft-stations and skip-pockets is a decided success in this mine.

MORENO. During the half-year ended June 30, 1916, the Shannon Copper Co. made a profit of \$131,220. On account of labor troubles only five months were productive. The copper output was 4,268,000 lb., at a cost of 17.2c. per lb. The price received was 27.562c. Current assets over liabilities amount to \$991,106.

tion of Miners officials would arrive on the following day, and on Sunday a big meeting would be held.

At the Plymouth mine, where all men are non-unionists, work has been resumed at the request of a majority of the employees. The force includes 225 men.

GRASS VALLEY. Three feet of good ore has been opened at the bottom, 1000 ft., of the Golden Center shaft. At this company's Allison Ranch mine the ejector has lowered the water 70 feet.

KENNETT. Material is arriving for the Mammoth company's electrolytic zinc plant to be erected above the copper smelter. Excavating is also under way.

PLACERVILLE. The main shaft at the Pyramid mine has been re-tembered to a depth of 500 ft. It is being sunk another 200 ft. Fifteen men are working in charge of Charles Evans.

For the first time in 22 years the Badger Hill deep-gravel mine is being worked. An adit 650 ft. long will be driven.

SCALES. The concrete debris dam being constructed on Slate creek, Sierra county, is expected to be completed in about four weeks. The first 50 ft. of height will restrain 4,000,000 cu. ft. of gravel. Los Angeles people are supplying the money. Karl Brehme is in charge.

TAYLORSVILLE. During the half-year ended June 30, 1916, the Engels Copper Co.'s gross earnings were \$475,579, and profit \$226,225.

COLORADO

LEADVILLE. Adjoining the Harvard on north Fryer hill, the Progressive mine is being re-opened in charge of W. F. Page. Old workings at a depth of 280 ft. are being cleaned out. The shaft is 375 ft. deep. Water and litigation resulted in the mine being closed years ago. By the drainage operations of the U. S. S. R. & E. Co. the Progressive is now dry. Diamond-drilling is to be done.

At the Harvard shaft-bottom the U. S. S. R. & E. Co. is cutting out a large shaft-station. One Byron Jackson and two Krogh pumps are to be installed, each of 500-gal. capacity. Sinking will then proceed for 300 feet.

On October 1 the Empire Zinc Co. takes over the property purchased from the Small Hopes-Boreel company. Zinc-lead ore is soon to be regularly shipped over a new spur-line that the D. & R. G. will construct.

Hartman & Mock, who recently discovered rich gold ore on Red mountain, in the Twin Lake district, have brought in a ton that will average 150 oz. per ton. Since this strike many claims have been staked around the original one.

SILVERTON. On Bear creek, 5 miles west of this place, Bliss & Ahearn have obtained a lease on the Coughlin gold-silver mine. A tram is to be built to carry the ore to rail, thence to a mill at Silverton. A mill is needed in the Bear Creek district, where are said to be several good properties.

IDAHO

Dividends paid by companies in the Coeur d'Alene totaled \$1,409,125 in September, as follows: Bunker Hill & Sullivan, \$163,500; Caledonia, \$78,150; Federal M. & S., \$120,000; Hecla, \$150,000; Hercules, \$200,000; and Interstate-Callahan, \$697,485. This makes \$2,674,961 for the third quarter, and \$7,557,807 for 9 months.

BURKE. The Hecla company is employing 300 men, and is mining 750 tons daily. A mill is leased at Wallace, but this arrangement is inconvenient and uneconomical, although justified by present conditions. The company's mill at Gem may be enlarged from 450 to 650 tons, as recommended by the president, James F. McCarthy. The cash surplus is \$400,000.

ELK CITY. At the Comstock at Dixie a two-compartment shaft is to be sunk to a depth of 500 ft. A power-plant is to be erected later on. T. H. Minear and C. E. Shepperd are owners of the mine.—Work continues satisfactory at the Mineral Zone, Black Pine, Grangeville, Gold Drop, and Black

Diamond. The last named is sinking to 1000 ft., and employs 45 men.

KELLOGG. During the second quarter of 1916 the Caledonia company's profit was \$287,932. Dividends absorbed \$234,480. Shipments were 4079 tons of ore and concentrate having a gross value of \$435,346, made up as follows: lead, 2,574,680 lb., \$188,146; silver, 294,242 oz., \$200,578; and copper, 167,233 lb., \$46,622. Smelter deductions for freight and treatment totaled \$110,927, making the net smelter returns \$324,419. The operating cost was \$36,486, of which \$29,726 was for mining, \$5852 for milling, and \$907 for shipping. Development was continued on the Keating tunnel level. So far this has been unsuccessful, finding neither the ore nor the vein. It is proposed to continue the search so long as there is a possible chance of success. There are 2 years' reserves opened.

LOON CREEK. The new 50-ton mill of the Lost Packer copper mine is giving good results. The process is simple, including a jaw-crusher, ball-mill, thickeners, and flotation machines. S. M. Morris was in charge of construction. The ore averages 4% copper and \$8 to \$10 gold and silver per ton. The plant may be doubled. Concentrate is hauled by motor-trucks, formerly by hundreds of horses, to rail, thence to Utah smelters. The local smelter is not used now. Hydro-electric power is available.

MULLAN. In a raise above the lower adit, in a distance of 4000 ft., the Silverado mine reports the opening of 6 ft. of gray copper ore assaying 50 oz. silver per ton. This is at a vertical depth of 1400 ft. A 100-ton mill is expected to be complete in about two weeks.

PINE CREEK. The option on the Douglas zinc mine in the Pine Creek district, held by the Anaconda company, has been extended for six months, according to official announcement at Butte. Development of the property under the Anaconda company's management is proving satisfactory.

MICHIGAN

THE COPPER COUNTRY

HOUGHTON. It is expected that the Ahmeek, Allouez, Calumet & Hecla, Copper Range, Hancock, Isle Royale, Lake, Mass, Osceola, and South Lake mines will produce more ore and metal during September.

At the White Pine Extension the shaft is down 200 ft. To test the ore by flotation a small plant is being erected.

Calumet & Hecla reports as follows for August and for 8 months, in pounds:

Ahmeek	2,173,439	15,375,731
Allouez	870,758	6,753,289
Calumet & Hecla.....	6,603,418	50,933,908
Centennial	207,486	1,667,445
Isle Royale	1,199,162	8,215,502
La Salle	109,032	835,220
Osceola	1,625,498	13,235,178
Superior	192,463	2,133,948
Tamarack	513,441	4,436,518
White Pine	426,152	2,894,565

The district's September output will be a good increase.

MISSOURI

JOPLIN. The largest shaft in the district, that of the Empire Zinc Co. at Galena, is down 90 ft. The opening is 6 by 15 ft. in the clear, and is to be sunk to 280 ft. Two by four-inch cribbing was used in the upper part, but 8 by 8-in. timber is now used.

Owing to better prices for ore last week there were larger 'turn-ins' of zinc and lead concentrates. The Oronogo Mutual company made a record of 488 tons. The output of the region was 6554 tons of blende, 138 tons of calamine, and 1102 tons of lead, averaging \$59, \$39, and \$69 per ton, respectively. The total value was \$471,902.

MONTANA

ANACONDA. The second of two cars of zinc carbonate ore from the old Blue-Eyed Nellie mine, 6 miles west of this centre, returned 38.85% zinc at the Bartlesville Zinc Co., Oklahoma. This is probably the first ore of this character shipped from Montana. In the late 80's this mine yielded a good deal of lead-silver ore. The ore occurs in limestone.

BUTTE. The Butte & Great Falls company has purchased the Snowdrift and Rio Tinto claims. This makes a property of 186 acres. Diamond-drilling is under way on the 500-ft. level. The shaft is next to be sunk to 1000 ft. In a 700-ft. cross-cut at 500 ft. depth are several promising zinc-lead-gold-silver veins. R. M. Green is manager.

In the eastern part of the Butte district the North Butte company is to drive a 2000-ft. adit to cut a number of veins at a depth of 500 ft. The company owns 700 acres in this section.

On the 100-ft. level of the Bullwhacker a vein of sulphide ore assaying from 4.94 to 21.24% copper has been cut. Some of the drillings assayed 3.5 oz. silver, the first time that any ore in this mine contained the precious metal.

ELKHORN. "Mining in Jefferson County" is the title of a leaflet compiled by C. H. Vorek and published by the Jefferson County Mining Bureau. The centre of the area is about 25 miles south of Helena. The districts are Amazon, Boulder, Cataract, Colorado, Elkhorn, Lump Gulch, Mitchell, Montana City, and Jefferson City. Capital and development are necessary for these districts. Elkhorn is the centre of a promising group of claims. The formation in granite, and the ore deposits are found in this and at its contact with limestone, also in limestone and andesite. The old Elkhorn mine has been a large silver-gold producer. It has large tailing dumps requiring treatment. Other mines yield copper and lead ore with the precious metals. The Golden Curry, Moreau, Montana & Dolcoath, Elkhorn Bulwer, Elkhorn Queen, Tacoma, and others are being actively developed, some shipping ore.

HELENA. Fifty-one miles from this place and eight from Flesher the O. & M. Mines Co. is completing a 150-ton mill. Ore reserves are 15,000 tons, assaying 60c. gold, 12 oz. silver, 15% lead, 1% zinc, and 1.5% copper. Development has been under way for a year. Forty men are employed in charge of H. Johns.

From October 1915 to September 1916, inclusive, the Scratch Gravel company's smelter receipts totaled \$119,947 net from 2847 tons of ore. The main shaft was sunk to a depth of 500 ft. Drifts on this level have opened 7 ft. of lode-matter which contains 12 to 30 in. of good ore. On the 250-ft. level there is 16 in. of \$65 to \$161 ore, and a stope assays over \$65 per ton.

IRON MOUNTAIN. The Intermountain company, operating the old Amador mine, pays a half-cent per share, equal to \$8000, on October 20. This is an initial declaration.

NEVADA

(Special Correspondence.)—The Nevada Consolidated is working full time, extracting 12,000 tons of ore daily, of which from 1800 to 2000 tons is from the Ruth mine's underground operations. The system of glory-holing a level underground by itself, one block at a time, appears to be working satisfactorily. This saves a great deal of timbering. Owing to the ground being of a swelling nature many of the main haulage drifts had to be re-timbered as many as a half-dozen times. One drill is prospecting the ground near Keystone acquired some time ago for dumping purposes, to ascertain if whether there is any ore underground or not. Two drills are prospecting in the bottom of the pits; also more drilling is being done continuously around the Ruth mine. It is understood that these results are satisfactory in proving the existence of more ore. At the smelter the roasting capacity is being enlarged. Work is progressing on additions to the crushing plant.

There are 45 men employed at the old Giroux, cleaning-up the Morris underground, also on the Coppermines proper, near the Star Pointer shaft. It is announced by the local management that the Salt Lake Engineering Co. has closed a contract to overhaul the old Pilot Knob Hill mill of the Giroux, to treat 1000 tons per day. They expect to be able to start with the first 500-ton unit within three months. Several millmen and carpenters are at work. The Callow system of flotation will be used. The public has been misled so many times with the Giroux that it will have to be shown, and by a new management.

The old Ward mine, 18 miles south of Ely, which has a past production of about \$5,000,000, now supposed to have 500,000 tons of low-grade silver-lead ore blocked out, is being reopened by Denver people, in charge of Mr. Johns.

The U. S. Tungsten Co. has leased most of its ground in blocks on a sliding-scale for the ore. Most of the tungsten properties, except Shepherds at Tungstonia, are closed down owing to low prices of the mineral.

Ely, Nevada.

GOLDFIELD. During August the Junbo Extension shipped 2444 tons of ore, averaging \$29.46 per ton. The net profit was \$23,000. Daily production is 100 tons, 6 days per week.

GOODSPRINGS. August shipments totaled 107 cars, containing 4815 tons. Of this, 70 cars were from the Yellow Pine, 6 from the Anchor, 4 from the Boss, and the remainder in 1 and 2 carload lots. The Boss mine has opened high-grade copper carbonate ore in a lower adit.

In Devils canyon the Christmas company is to re-erect a mill purchased from the Addison mine. A road had to be constructed through difficult country.

HORN SILVER. It is likely that a 100-ton custom mill will be erected for this district. For this purpose the Orleans Mining & Milling Co. has been formed with J. W. Dunfee as president, and E. C. Edwards of Goldfield as secretary.

ROCHESTER. At the Nenzel Crown Point mine the cross-cut was driven 415 ft. in 30 days. It is in a total of 1100 ft. Five well-defined veins of good value were cut, one being 85 ft. wide. The cross-cut will be extended to open the zero vein, which will also improve ventilation.

UTAH

ALTA. No. 4 drill in the Old Emma has passed through 21½ ft. of ore assaying 116.7 oz. silver and 8.5% lead, at a depth of 210 ft. C. S. Herzog is directing exploration, with J. J. Beeson as geologist in charge, the latter having said that the ore shows galena and pyrite disseminated through a compact mass of quartz, with here and there small cavities lined with well-formed crystals of quartz and galena. Argentite, the sulphide of silver, apparently is also present. This is further evidenced by the high silver-content in the first part of the core which was assayed. The unoxidized nature of the ore, the apparent absence of secondary minerals, and the large amount of quartz in the gangue, leads to the conclusion that the high-grade ore encountered will persist to depth. The character of the quartz as shown in the core indicates that the mineralization has been effected by deep-seated solutions coming up through fissures in the rocks and replacing the limestone. It could not possibly have come from waters infiltrating from the surface. In hole No. 2, 80 ft. away, the half-inch of galena is evidently connected with the body cut in hole No. 4, as was intimated at the time hole No. 2 was put down. The importance of this strike cannot be over-estimated. The actual visualizing of this ore is the only remaining proof that was needed in the chain of facts which have been gathered.

No. 6 drill hole has since cut 5 ft. of better ore than that passed through by No. 4. The ore contained more galena.

It is proposed to consolidate the Old Emma Mines Co. and the Emma Copper Mining Co.

PARK CITY. The Silver King Coalition Mines Co. distributed 15¢ per share on October 1, equal to \$187,500.

TINTIC. The Eagle & Blue Bell shaft is down 1876 ft. Production is restricted by the smelters to 50 tons of ore daily.

WASHINGTON

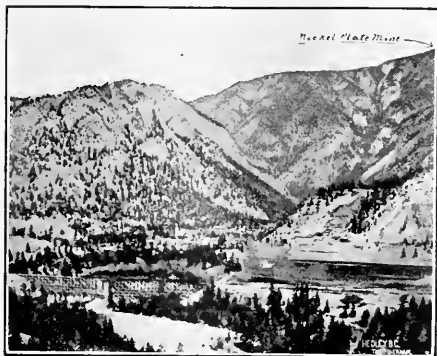
NORTHPORT. Two more furnaces have been blown-in at the smelter. Treatment problems are no longer a trouble, and the coke supply from British Columbia is more regular.

REPUBLIC. According to S. H. Richardson of the Knob Hill mine the silicious ore of this district is in great demand at the Trail and Grand Forks smelters, British Columbia. Greenwood and Northport also require some of the ore.

CANADA

BRITISH COLUMBIA

Dividends paid in September totaled \$413,877, as follows: Consolidated Mining & Smelting, \$210,688; Hedley Gold, \$60,000; Standard, \$50,000; and Crow's Nest Coal, \$93,189. For



IN THE HEDLEY DISTRICT OF BRITISH COLUMBIA.

the third quarter the total is \$855,738, and for 9 months \$2,520,591.

HEDLEY. On September 2 the Hedley Gold Mining Co. will pay its quarterly dividend of 3%, also an extra of 2%.

ONTARIO

COBALT. During August the Kerr Lake company produced 244,020 oz. of silver, an increase of 33,020 oz. over that of July.

PORCUPINE. The Hollinger is employing 1200 men. Foundations for the new mill are nearly finished. This will consist of 100 stamps, 10 tube-mills, etc. The new central shaft plant will be ready next March. The consolidated properties are being connected at the 425-ft. level.

On the 400-ft. level of the McIntyre the Jupiter vein has been cut. The mill is treating 400 tons daily. An aerial tram is to be constructed across the lake to haul 75 tons of ore per hour.

MEXICO

In the president's half-yearly report of the American Smelting & Refining Co. he states that the company has again to record the entire lack of earnings from its very valuable properties in Mexico.

The AMERICAN MINING CONGRESS will hold its 19th annual meeting at the Hotel La Salle, Chicago, during the week of November 13. A large attendance is expected, and interesting exhibits are to be shown. Papers are to be read by well-known mining men. J. F. Callbreath is secretary.

The MICHIGAN COLLEGE OF MINES at Houghton has issued its year-book of 113 pages for 1915-16, with announcement of courses for 1916-17. The fall term begins on October 2. A good map of the copper country is included.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

R. A. KINZIE is on his way to Arizona.

EDWIN E. CHASE and son are in southern Nevada.

ROBERT THOMSON, JR., has returned from Siam to Scotland, to enlist.

W. W. MEIN has been visiting the Mother Lode district, California.

HOWARD D. SMITH has returned from a visit to New York and London.

EDWARD H. COOK is returning to the Topia district in Durango, Mexico.

VICTOR C. ALDERSON and JOHN M. BAKER called at this office during the week.

W. H. STAYER has been at Silver Plume, Colorado, but is now at Washington, D. C.

T. M. SKINNER is assistant manager for the Potash Products Co. at Alliance, Nebraska.

J. O. CLIFFORD was in San Francisco on his way from Salt Lake City to Miami, Arizona.

W. D. ABEL is superintendent for the Three R Mining & Milling company at Patagonia, Arizona.

W. D. MANCHESTER is superintendent of the crushing department of the Chile Copper Co., at Chuquicamata.

FREDERICK R. BURNHAM is at the Pasadena hospital, where he has undergone the operation for appendicitis.

H. C. HARRISON is now operating the Three R mine at Patagonia, Arizona, having left Mexico for the present.

FRED HELLMAN has been appointed consulting engineer to Guggenheim Brothers, successors to M. Guggenheim's Sons.

W. A. CLARK, JR., WILLIAM BURGESS, and H. V. WINCHELL are visiting the Denning mining district in Owyhee county, Idaho.

GUY C. WARFEL has been appointed Assistant Professor of Mining Engineering at the State College of Mines of Washington.

ARTHUR K. ADAMS has left for Chile, where he will act as geologist for the Andes Copper Co., a subsidiary of the Anaconda company.

EDWIN S. BERRY, who has joined POPE YEATMAN in consulting practice, sailed for Peru on September 16 to examine mines in that country.

GEORGE R. ALLEN, manager of the Chosen Minerals Co., Seoul, Korea, is returning at an early date. He was recently at Atolia, California.

ROBERT E. CRANSTON has been appointed consulting engineer to the Mining Associates, Ltd., operating the Rawley mine, near Salida, Colorado.

S. M. MORSE has been appointed general superintendent of the Superstition Consolidated Mining Co., eight miles north-east of Price, Arizona.

O. J. FISK and R. J. GOODWIN are engaged in a series of chloridizing roasting and leaching experiments on the copper-platinum ores of the Boss mine, at Goodsprings, Nevada.

JOHN V. BECKMAN, for many years connected with the Lidgerwood Manufacturing Co., died at Plainfield, N. J., on September 11 at the age of 74. About 1870 he engaged in the manufacture of rotary engines, pumps, etc. His company was absorbed by the Lidgerwood company in 1873, Mr. Beckman assuming charge of the works of that company, and was the inventor of many improvements in hoisting-engine design. For many years he had been a member of the American Society of Mechanical Engineers.

THE METAL MARKET

METAL PRICES

San Francisco, September 26.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	23
Pig lead, cents per pound.....	7.25-8.25
Platinum: soft and hard metal, per ounce.....	\$90-95
Quicksilver: per flask of 75 lb.....	\$73
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, September 26.

Antimony: 50% product, per unit (1% or 20 lb.)....	\$1.00
Chromite: 40% and over, f.o.b. curs California, per ton.....	13.00-15.00
Manganese: 50% (less than 35% metal not bought).....	11.00
Magnetite: crude, per ton.....	8.00
Tungsten: 60% Wb, per unit.....	13.00

Mica bulletin of the U. S. Geological Survey for 1915 is issued. Sheet mica averaged 68c. per lb., against 59c. in 1914 and 21c. in 1913. Mica must be 3, 6, 9, 14, 24, and 36 in. square. Bismuth in New York is quoted at \$5.50 per pound.

New York, September 29.

Antimony: There is no change, with the market at \$1 to \$1.10 per unit for prompt delivery.

Tungsten: Foreign business has been quiet this month because of cable delays. Foreign inquiries are still under negotiation, but domestic consumers are out of the market. The present quotation is about \$17 per unit.

EASTERN METAL MARKET

(By wire from New York.)

September 26.—Copper is active, spot metal is not quoted, and first quarter is 27.50c.; lead is also active, with good export demand; spelter is dull under reaction.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Sept. 29.....	68.62
" 21.....	68.87
" 22.....	68.81
" 23.....	68.87
" 24 Sunday.....	69.25
" 25.....	69.25
" 26.....	69.25

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	.....
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	.....
May	58.21	49.87	74.27	Nov.	49.12	51.88	.....
June	56.43	49.03	65.04	Dec.	49.27	55.34	.....

The silver market is strong with steady advances. London reports that fresh supplies are by no means plentiful, and the stock is only 7,000,000 oz., 75% of a month ago. China has not ceased releasing portions of its largely depleted silver currency holding. One of the Indian native states purchased \$480,000 of silver for coinage. The holding of silver coin in the Indian treasuries continues to shrink.

Silver worth \$591,000 (1,300,000 oz.) was shipped from San Francisco to the Orient on September 23.

Last week the Calumet & Hecla shipped silver worth \$35,000 from its copper refinery at Hubbell, Michigan.

COPPER

Prices of electrolytic in New York, in cents per pound

Date	Average week ending
Sept. 29.....	28.37
" 21.....	28.37
" 22.....	28.37
" 23.....	28.37
" 24 Sunday.....	28.25
" 25.....	28.50
" 26.....	28.75

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.8	19.09	25.66
Feb.	14.16	14.38	26.62	Aug.	12.4	17.2	27.93
Mch.	14.11	14.80	26.65	Sept.	12.4	17.65	...
Apr.	14.19	16.61	26.62	Oct.	11.10	17.90	...
May	13.97	18.71	29.02	Nov.	11.75	18.88	...
June	13.60	19.75	27.17	Dec.	12.75	20.67	...

On September 29, Phelps, Dodge & Co. paid \$2.50 per share and an extra of \$5.50. Granby Consolidated is paying \$2 per share.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Sept. 29.....	7.00
" 21.....	7.00
" 22.....	7.00
" 23.....	7.00
" 24 Sunday.....	7.00
" 25.....	7.00
" 26.....	7.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	....
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	....
May	3.90	4.24	7.38	Nov.	3.68	5.15	....
June	3.90	5.75	6.88	Dec.	3.80	5.34	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Sept. 29.....	9.50
" 21.....	9.75
" 22.....	9.37
" 23.....	9.25
" 24 Sunday.....	9.25
" 25.....	9.25
" 26.....	9.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	.....
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	.....
May	4.91	17.03	16.01	Nov.	5.01	17.20	.....
June	4.84	22.20	12.85	Dec.	5.40	16.75	.....

Zinc ore at Joplin is \$5 per ton higher, the range for 60% metal-content being from \$50 to \$65 per ton. Butte & Superior concentrate, 53%, was worth \$19.45 per ton in August.

New Jersey Zinc shares are now quoted at \$315, giving the company a valuation of \$110,250,000. Earnings are at the rate of \$96 per annum.

When the American Zinc, Lead & Smelting Co. and Granby Mining & Smelting Co. merger is complete, the former will have 22,404 re-torts, with an annual capacity of 78,414 tons of spelter, and will rank as the third largest individual factor in the industry in the United States.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date	Sept. 12.....	75.00
Aug. 29.....	77.00	75.00
Sept. 5.....	77.00	73.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	232.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	.....
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	.....
May	39.00	75.00	90.00	Nov.	55.00	101.50	.....
June	38.60	90.00	74.70	Dec.	53.10	123.00	.....

Last week 200 flasks were shipped to Japan from San Francisco.

TIN

Prices in New York, in cents per pound.

Monthly averages

1914.			1915.			1916.		
Jan.	37.85	34.10	11.76	July	31.60	37.38	38.37	
Feb.	39.26	37.23	12.60	Aug.	50.20	34.37	38.88	
Mch.	38.10	48.76	20.50	Sept.	33.10	33.12		
Apr.	36.10	48.25	21.19	Oct.	30.40	33.00		
May	33.29	39.38	19.10	Nov.	33.51	39.50		
June	37.72	40.79	42.07	Dec.	33.60	38.71		

ANTIMONY

The market is full of a heavy with re-sellers offering Oriental grade, at 11 to 11.50c. duty paid.

ALUMINUM

In the past week quotations strengthened somewhat, and up to 64c. was asked for No. 1 virgin metal, 98 to 99% pure, but the price has since settled around 61 to 63 cents.

Eastern Metal Market

New York, September 20.

Great quantities of copper have been purchased in the past few days, and the market is stronger. Near-by metal is scarce so far as the producers are concerned, some having but little metal not under contract for the remainder of the year. Near-by is quoted at 28.50 to 29c., and December at 27.75 to 28c. The enormous order of the Allies for 1917 has not been placed, but brass rod and disc requirements amounting to 40,000 tons have been covered. The large sales are quietly negotiated, and the prices obtained undoubtedly below what even large domestic consumers would have to pay.

Zinc has continued active, and is a little higher.

The A. S. & R. Co. has twice advanced its quotations for lead, now asking 7c., New York. Independents quote 7c. or higher.

Tin has been quiet, but the market expects a buying movement to develop soon.

Antimony is dull and easy.

Aluminum shows greater strength.

A leading feature of the steel trade is the overwhelming demand for plates, for which 4 to 4.50c., Pittsburg is now obtained. Middle Western consumers are begging the Eastern Pennsylvania mills for material. The demand for structural steel is not so urgent as that for other products. Independent structural shops took orders in August equal to 64% of their capacity. Generally, the tendency is toward higher prices as deliveries become more difficult. It is seen that Europe will take all the material that America can supply. Thousands of freight-cars are needed by foreign and domestic railroads. The plate mills are confronted with inquiries for at least 300,000 tons, deliveries to run through 1917. Three ships to be completed in the first quarter of 1918—about 18 months away—have been placed with Pacific Coast yards.

COPPER

So far as can be learned the requirements of Great Britain and her Allies for their first half of 1917 requirements, reported to be 125,000 tons, have not been satisfied, although negotiations are actively under way. In the past week, however, orders for at least 40,000 tons of brass rods and discs have been placed with brass mills, and the latter have either bought or obtained options on the copper and spelter required to fill the orders. Last week's business in copper is estimated at close to 75,000,000 lb. Near-by metal is scarce, in fact, there is not much to be had for the remainder of the year. One producer of electrolytic stated that he has none to offer this year, and wants 27.50c. for the first half of 1917. The exact level of prices is difficult to gauge for the reason that the near-by market is largely in the hands of second-hands, and a wide range of quotations prevails. Sales, to a large extent, are a matter of quiet negotiation, and sometimes details do not leak out. December is quoted at 27.75 to 28c. and near-by at 28.50 to 29c. Producers of Lake are sold-up to the end of the year, and its market is purely nominal, at approximately the same levels as exist for electrolytic. The London electrolytic market yesterday was stronger at £135 10s. against £132 a week previous. Exports from September 1 to 20 totaled 16,310 tons. Stocks in France and Great Britain on the 15th totaled 7118 tons, against 7514 tons, a decrease of 396 tons.

The general situation in copper looks strong for months to come.

Exports in eight months totaled 215,199 tons, compared with 171,786 tons in the period of last year. France took almost half, and England a quarter of this quantity.

ZINC

The market has continued active, although business has

been lighter than it was last week. It cannot be expected that a heavy movement will last indefinitely. The brass mills, which have booked the large orders for rods and discs, were active in covering their needs for these products. There has been a good demand for extra choice zinc, and for prime Western. The quotation for prompt prime Western at New York yesterday was 9.75c., and at St. Louis 9.50c. Fourth quarter was held around 9.37½c., St. Louis, and first quarter at 9c. Not only did the galvanizers take considerable quantities of prime Western, but that grade was taken also by brass mills which have come to using ordinary spelter for purposes for which "special" was formerly considered essential. It is conceded that the finished product is not as good as where brass-mill special is used, but it passes muster for various purposes. The trade is surprised that the recent buying did not send zinc up more sharply, and to higher levels than have been reached, and in explanation it is said that the smaller producers checked the advance by passing out their metal for disposal by dealers and brokers. Such activity as prevailed in recent days would have sent prices soaring a few months ago. Another influence, tending to keep the market down, is the quiet manner in which much of the buying has been done, thereby eliminating unnecessary competition. Makers of the higher grades of metal are well sold-up for the balance of the year. Exports of the month have been heavy, up to the 20th, totaling 6723 tons. The spot quotation at London yesterday was £56, against \$52 a week previous. The quotation for sheet zinc is unchanged at 15c., f.o.b. mill, carload lots, 8% off for cash.

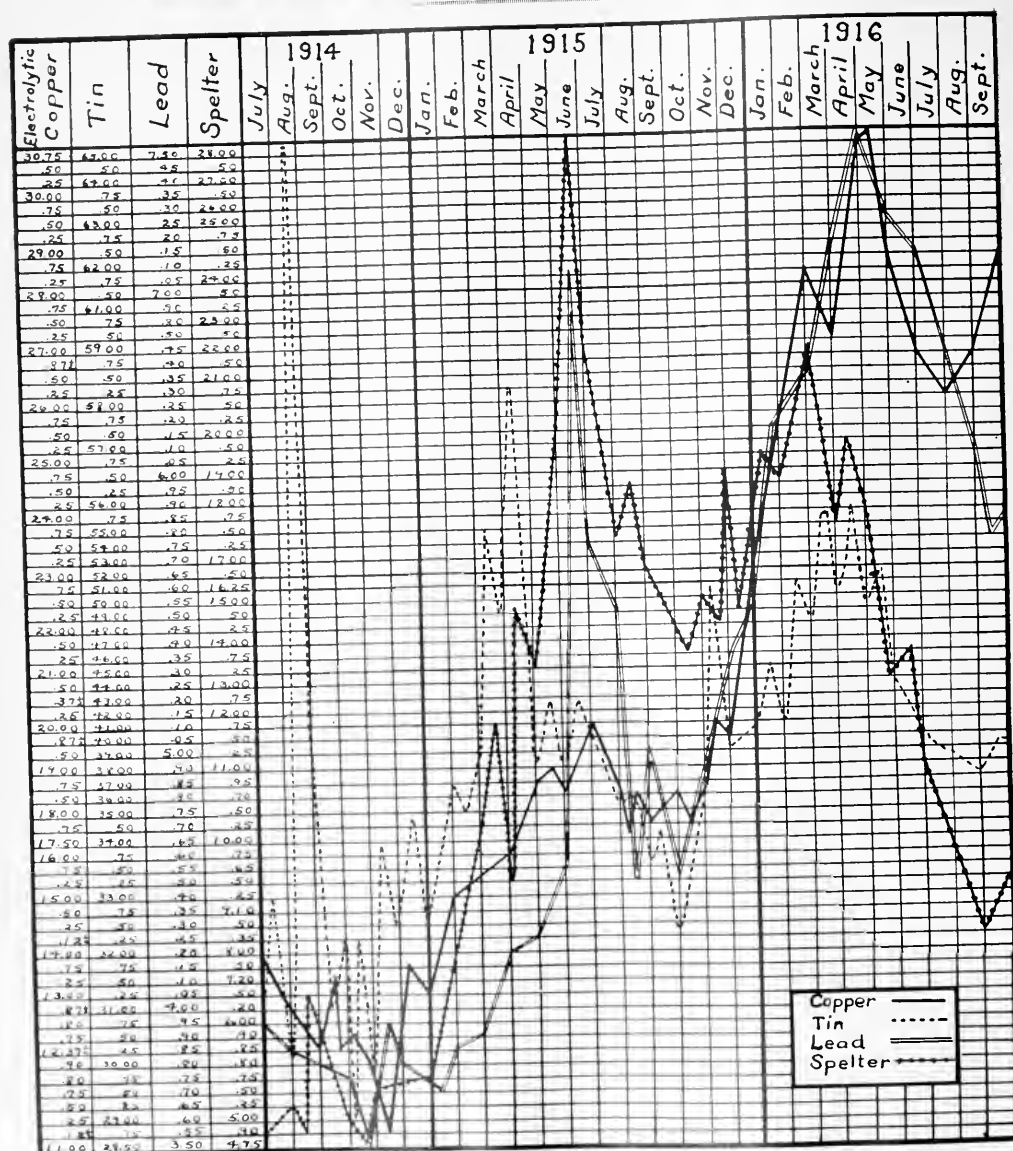
LEAD

Buying of prompt and near-by metal has been active, and the excellent volume of orders which independent producers have been booking, many of them at premium prices, is the evident cause of two advances, each of ½c. by the A. S. & R. Co. On September 14 the company advanced its New York quotation from 6.50 to 6.75c., and on the 19th it made a further advance to 7c. Until the latter price was announced, independents had been easily obtaining premiums of ½c. or more over the quotation of the leading interest. Some of them are today asking 7.10c., New York. The St. Louis quotation of the A. S. & R. Co. is now 6.92½c. The independents are asking 6.85c. Up to the time the leading interest advanced from 6.75c., a heavy and widely distributed business was done. The big producer at the time was selling only to regular customers, and for October delivery, but only at its average price for that month. Outsiders made sales for October at 6.70c., New York. No surprise was expressed at the action of the A. S. & R. Co., the only wonder being that the advances did not come sooner. Near-by metal is scarce. Exports of lead have continued light, amounting so far this month to only 771 tons. The London spot market was quoted yesterday at £30 15s., or 15s. higher than a week ago.

TIN

The main feature in tin, which has been quiet in the past week, is that events are apparently shaping themselves for a good movement. It is some time since consumers have been in the market to any considerable extent, their contracts are nearly liquidated and their supplies must be getting low. Therefore sellers are looking for a movement in the near future. On one or two days in the week moderate interest was shown, but at no time was buying noteworthy. The spot quotation for Straits yesterday was 38.50c. The supply of Banca has been pretty well cleaned-up. Arrivals of the month up to yesterday totaled 1590 tons, and there was afloat 3590 tons.

Metal-Price Fluctuations During the War



THIS CHART, ORIGINALLY PUBLISHED IN *The Daily Metal Reporter*, NEW YORK, SHOWS THE MOVEMENTS OF METAL QUOTATIONS FROM JULY 1914 TO SEPTEMBER 1916, INCLUSIVE.

Prices of Old Metals

Nominal quotations in New York are as follows, in cents per lb.:

Heavy and crucible copper	23.00
Copper turnings	18.00
Heavy brass	13.00

Heavy lead	5.75
Zinc	6.75
Cast aluminum	32.00
Tin pipe	34.50
No. 1 pewter	23.00
Electrolytic scrap	6.50
Solder joints	8.25

EDITORIAL

T. A. RICKARD, Editor

THE American Mining Congress will hold its 19th annual session at Chicago on November 13 and following days. An interesting convention is assured.

MONEY is being made on paper at a terrific rate just now on Wall Street, but some of it will be like Carranza currency when the day comes for cashing.

ON another page we publish an account of the Institute meeting in Arizona. It appears that the visiting members saw a great deal and heard a great deal that was deeply interesting.

INTERNATIONAL Paper shares continue to soar, reflecting thereby the artificial rise in the cost of a product used by all of us and squandered by most of us, particularly the daily newspapers. If the high cost should lead to a diminished production of piffle, especially for Sunday consumption, the public would be benefited.

STOCK SPECULATION on Wall Street is becoming reckless, suggesting a fever of gambling that can only do great harm to the public. The decrease in the grain harvests, the labor unrest, the Mexican position, and the possibilities of complications with belligerents should deter the continued expansion in quotations. We are not out of the woods yet.

COPPER and the big dealings in that metal are discussed by our New York correspondent in his review of the market. He suggests that this big purchase of copper will be followed shortly by proportional buying of zinc, to make brass. Our own further remarks on the subject of copper quotations are held over until next week, owing to the exigencies of space.

OFFICIALS of the American Smelting & Refining Company are informed that bandits have burned the buildings and store-house at the Sierra Mojada mines, in Chihuahua. The American staff of the Real del Monte mines, owned by the United States Mining, Smelting & Refining Company, is returning to Pachuca, in Hidalgo. The reader can take his choice as to which incident best reflects conditions in Mexico.

BY Carranza's decree of September 12 any mine in Mexico that shuts down for two months consecutively or for three months in the aggregate per annum is to be confiscated to the Government, which also decides how many men are to be employed in order to comply with this ruling. However, such a pin-prick will not

add greatly to the injuries being done to mine-owners in Mexico. They are counting on a change of policy at Washington in March next. In our news columns we give further particulars concerning this latest decree of the *de facto* government.

CLASSIFICATION does not affect the thing classified, but it does affect the mental attitude and understanding of the classifier. For the sake of clear thinking correct categories are important, as Aristotle demonstrated some milleniums ago. The mental attitude of the American people toward the Mexican muddle will also be materially improved, with a hopeful probability of assisting thereby to a solution of some part of the problem, by adopting true definitions. The other day when Villista forces attacked Chihuahua it was reported as a "bandit victory"; when a Villista general meets with an unwelcome reception at Cusihuiriachic the "bandits are routed." The word 'bandit' in the English language signifies a group of common highway-men, out for plunder, and possessed of no patriotic aims. We as a nation shall gain a better perspective, and shall the sooner apply sane policies to the end of pacifying unhappy Mexico and of letting unfortunate American investors return to their work in the battle-torn republic if we cease to apply approbrious epithets indiscriminately to men who are fighting with a purpose, and recognize the fact that Carranza is dealing with sporadic revolution, likely to crystallize at any moment under some leader into formidable organized rebellion.

ECONOMIES effected in the production of copper are due not only to the rapid advance in metallurgy during the last few years but also to the improved methods of mining. In this issue we publish an article by Mr. George R. Lehman describing the practice of the Inspiration Consolidated Copper Company. As applied in the Inspiration mine it is a modification of the system used by the Ohio Copper Company in Utah, described by Mr. F. Sommer Schmidt in our issue of March 6, 1915. This method of mining is highly efficient and economical when applied to a large orebody of uniform grade covered by a cap that when under-cut caves readily but does not break into small stuff. Among the advantages are the small amount of timber required, economy in the use of powder, less shoveling, less danger of falls, and greater productivity in development work, which is done in the ore. A great deal of preparatory work is necessary before caving can be started, but in the interval it is possible to draw some ore. A disadvantage is the unavoidable mixture of ore with waste from the cap, reducing

the grade. What dilution is economic and what ore is likely to be lost must be determined by experiment. Care is necessary to avoid an excessive amount of waste, especially when drawing the last of the ore from a caved level. While the method is essentially the same in Utah and Arizona, a few changes have been made at the Inspiration mine. Less cross-cutting and driving is done on the caving-level, as the blocks are 25 by 150 feet instead of 20 by 50 feet. The drilling and placing of the holes has not been changed but the rounds are blasted singly, retreating from the edges of the block. As practised in Utah, the whole block of the caving-level is shot down by simultaneously firing all the rounds. The distance between caving-levels has been reduced from 60 to 35 feet. The success of the method is indicated by the cost, which is now 60 cents per ton and will be less when working the next under-cut.

Concreting a Shaft

The main shaft is to the mine what the trunk line is to the railroad. Safety is the first consideration, uninterrupted traffic the second. As a means to these ends the Copper Queen Consolidated Mining Company decided to concrete its Sacramento shaft. To do this without interrupting traffic was no small problem. The shaft was in constant use; the space between guides was so small as to be impossible of utilization for working-platforms. The fifth compartment of the shaft therefore was utilized as a passage-way for the concrete pipe-line, the concrete mixture being spouted by gravity into the forms through a 4-inch pipe in 10-ft. lengths in order that replacements for wear might readily be made in short, rather than standard-length, sections. Compressed air as a carrier for the concrete was employed, the air under pressure performing the double function of carrying the concrete to the forms and depositing it therein under such pressure as to compact the mass even better than could be done by hand-tamping. This method was used in San Francisco for both the Stockton Street and the Mile Rock tunnels, the concrete being so dense as to show the grain of the wood used for forms. At Bisbee the self-supporting steel forms were designed so as to be collapsible. The guides were left in place, the jar and vibration of the skips in passing having the effect of helping to shake the concrete into place in the forms, compacting the mass. Even the beams to which the guides were finally attached were of reinforced concrete. The total cost of the work was \$80,623; this includes all preliminary work as well as the actual concreting. The result is a fire-proof, practically water-proof, permanent main artery of traffic from mine to surface, through which ore, waste and men may pass without interruption as long as the mine continues to be productive. To the owner of a prospect, a concreted shaft would be an expense wholly unjustifiable. To the owner of a real mine, anything else is extravagant. When the character and volume of the ore deposit are such that the mine manager can see his way clear toward production for a term of years sufficiently long

to take into consideration the last as well as the first cost, the expense per ton of output per year for concrete as compared with wood should show clearly in favor of the former, leaving out of consideration the security from fire-risk. The Copper Queen Company is a pioneer in this type of shaft construction, although concrete has been used in shafts elsewhere in Arizona. The Bunker Hill Mining Company, in California, is about to undertake a similar work. Indoubtedly the article on the Sacramento shaft will stimulate other companies to do the same. We join with our readers in thanking the distinguished engineer that veils his identity under the initials 'G. S.' for placing on record his experience and that of his staff in this important engineering work.

The Wilmington Decision

On Saturday last Judge Bradford, of the U. S. District Court, at Wilmington, Delaware, filed his opinion in the case of Minerals Separation against the Miami Copper Company. The decision sustains the plaintiff, declaring infringement of claims No. 1 and No. 12 of the first patent and all of the second patent, but it declares invalid claim No. 9 of the first patent and all of the third patent. This opinion is based on the patentability of a reduction in the quantity of oil to less than 1% of the weight of the ore treated. At an early date we shall publish the full text of the decision. Meanwhile it may be explained that the first patent in suit is No. 835,120 issued on November 6, 1906, to Sulman, Picard, and Ballot. The corresponding British application for patent was filed on April 12, 1905. Claims 1 and 12 are as follows:

"1. The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of 1% on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation."

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of 1% of oil on the ore, agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture."

Claim 9 is the broadest in the patent, it reads:

"The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, agitating the mixture to form a froth, and separating the froth."

In this claim the proportion of oil is not specified; it is mentioned as "a small quantity." The second patent is No. 962,678 issued on June 28, 1910, to Sulman, Greenway, and Higgins. This patent is the one for a process in which a soluble frothing agent is employed. The third patent is No. 1,009,699 issued on June 9, 1914, to Min-

erals Separation as assignee from H. H. Greenway. This patent refers to copper ores and claims the use of an aromatic hydroxy compound, such as phenol or cresol, in a neutral solution.

The main feature of Judge Bradford's opinion is the patentability of a reduction of oil to less than 1%. The pioneers of the flotation process used as much as 3 tons of oil to 1 ton of ore, their method being based on the relative specific gravity of oil and water, and the affinity of sulphide minerals for oil; the Minerals Separation people claim to have reduced the proportion of oil "close down in the neighborhood of 0.1%," as their brief states. This is equal to two pounds of oil per ton of ore. Others operating on their own initiative since then have conducted the process most successfully with two-fifths of a pound or one-fifth of 0.1% per ton of ore. But the reduction in the quantity of oil is not the main distinction between the oldest and the newest phases of flotation, the latter use the oil not to buoy the mineral directly but to modify the surface tension of the water in the presence of plenty of air so as to produce a froth that persists long enough to float the mineral through the pulp and away from the gangue. Judge Bradford, in effect, endorses the opinion given by Judge Bourquin in the Hyde case when it was tried before the District Court of Montana and he disagrees with the reversal pronounced in that case by the Circuit Court of Appeals at San Francisco on May 4, 1914. Undoubtedly the Wilmington decision will be referred to a court of greater dignity, as happened in the Hyde case, which is now before the court of last resort. The present decision is immensely interesting, but it is not decisive.

The Far East Rand

This is an economic, not a political, designation. It refers to the eastern end of the great goldfield of the Witwatersrand, to an area of 240 square miles, of which 200 is underlain at a depth not exceeding 5000 feet by those beds of gold-bearing conglomerate from which nearly \$190,000,000 per annum is being extracted. Of the 200 square miles, 150 remain open to exploration. This represents a great economic asset, which the South African government would like to see productive. Of the annual revenue of the Union, one-half comes from the mines of the Rand. These are becoming exhausted at a rate threatening to throw the burden of taxation upon the other industries of the country, notably the agricultural, in which the Boer population is chiefly engaged. It is estimated that by 1929 fully half of the mines now productive will have depleted their supplies of ore; in 30 years the output will have fallen from \$190,000,000 to \$40,000,000 per annum. Hence the desire to promote the development and exploitation of the best remaining portion of the gold-bearing area.

The prospects are attractive. Up to the end of last year 11 companies had set to work in this eastern area, with results that speak for themselves: \$215,000,000 worth of gold has been produced from 26,681,884 tons,

and \$55,700,000 has been paid in dividends. The yield has averaged \$8 per ton and the dividends slightly more than \$2 per ton. The dip of the 'banket' in these mines ranges from 70 to 12°; in the unexplored area it is estimated that it will average 7°. The maximum depth of the workings is 4000 feet.

In 1908 the Government adopted a plan for leasing blocks of ground and in 1909 it invited applications for the right to mine on two areas, covering 1912 and 2037 acres respectively. Each application had to be accompanied by a guarantee of £35,000. It was estimated that £350,000 would be required in each case for shaft-sinking and preliminary development and a further sum of £350,000 for bringing the enterprise to fruition. Within two months after acceptance of the application, a limited liability company had to be registered in the Transvaal with a cash capital of at least £350,000. No shares were allowed to vendors or promoters, nor any underwriting commissions. The Government was to receive a proportion of the net produce, that is, of the profit after deduction for amortization of capital, on a sliding scale. Only one company, Barnato Bros., made application for both blocks. Later the Government offered sundry other blocks on successive occasions, but without tenders from the capitalists, who had come to a tacit agreement that the terms were not sufficiently attractive. Thus no business has been done since 1910.

A report was issued by the Government Mining Engineer, Mr. R. N. Kotze, early this year, reviewing the facts and suggesting amendments in the method of procedure, the principal change being to leave the initiative to the capitalist. A modification of the scheme of payments to the Government is also suggested. In addition to the ordinary profits tax, which is 10%, and the minor fees required by the existing law, the lessee will pay a further share out of his profit on a sliding scale. It is aimed to not penalize efficiency by exacting an increased share of the profit when this increase is due mainly to improved management, while allowing the Government to participate in the benefit accruing from a betterment in the grade of the ore. Mr. Kotze has suggested a modified formula, but his constants only cover particular conditions and it remains for him to devise, or for others to suggest, a scheme that will prevent an embargo on efficiency. This will be done, without doubt, for the Government Engineer has shown himself not only thoroughly capable but also fair-minded. Naturally, the Government wishes to have nothing to do with tonnage or any other arbitrary unit, the intention being to determine the profit made by the mine without the need for supervision; therefore the only factors considered are the gold placed in the bank and the cost as determined by an auditor, both items appearing in the company's published accounts.

More room for disagreement arises in the scheme of finance. The Government allows the operator to credit himself with 6% interest during the non-productive period preceding the commencement of milling and then allows 15% on the total accrued capital, together with 3% at compound interest for amortization, before ex-

acting its own toll on the profit of the operations. We question the soundness of this reasoning. Surely the money that is risked is deserving of at least as high a return before production commences as afterward; nay, is not the ratio of risk reversed, and should not the return be 15% at least before the productive period and more like 6% subsequently? When a mine of this character has been proved, when the ore is blocked out, the cost ascertained, and the future assured, then a return of 6% plus 4% for amortization of the principal should suffice, but until the undertaking is on a firm basis, while it is still an essentially hazardous venture, it should return a high interest, from 20 to 25%, to the operators. Then it is a 'speculation'; later it becomes an 'investment.' To this Mr. Kotze and many of the Rand engineers may demur, for they like to regard a Rand mining venture as *hors concours*, as something far less risky than the ordinary gold mine, as an 'investment' from the start. The story of the Witwatersrand flouts such unreasonable optimism; many of the sure things have proved disappointing; the mines have not been uniformly profitable. We repeat, the low rate of interest allowed during the incubation of the undertaking and the high rate conceded when the mine is firmly established on a fruitful basis is illogical.

Another factor regarding which a difference of opinion is permissible is the proportion of productive ground in the unexplored area. Mr. Kotze takes 60% as an average, the ground so far having been 15 to 85% profitably productive. Having regard to the fact that the most likely portion has been selected already, as far as can be judged by the evidence available, it seems to the observer at a distance that 60% is optimistic, and the assumption of it may retard good business, namely, the kind of business that proves beneficial to both parties in a given transaction.

Searles Lake Potash

In the news columns of a recent issue mention was made of the decision in the first stage of the litigation over the saline deposits of Searles lake in southern California. The matter is one of importance because this deposit is likely to become an important source of potash and the effort to exploit it has been under way for several years by a corporation financed by the Consolidated Gold Fields of South Africa, a British company that has played a big part in the development of the Transvaal and Rhodesia. The story of Searles lake and its mineral encrustations is worth reviewing. In January 1908 this lake-bed in San Bernardino county was located as a soda deposit by C. E. Dolbear, acting for himself and seven others, most of whom were resident in New York and New Jersey. These locators sold out shortly afterward to the California Trona Company, which borrowed money from the Foreign Mines Development Company, a subsidiary of the Consolidated Gold Fields of South Africa, a London corporation. The loan was secured by a mortgage that was foreclosed in 1909, the

final decree being granted in 1913. Control of the shares of the California Trona Company was acquired in 1911 by Mr. Guy Wilkinson, managing director for the Foreign Mines Development Company, so that title was vested in an American. Attempts to jump the locations were made in the spring of 1910 by Henry E. Lee. He sent a young engineer named Davidson, who died on the ground; and the survivors of his party assigned the locations they had made to the Trona company. In the autumn of the same year Mr. Lee sent another party, this time armed, for the same purpose, of locating claims, on the assumption that the original Dolbear locations were invalidated by the so-called Yard decision, in which case the Government had disallowed the placer claims staked by locators that had not shown good faith by supplying funds or appearing in person on the ground. Within a week after Lee's locations were made, one of his associates attempted to sell the locations to the Foreign Mines company and suggested that if they bought them the company could freeze out the real owners of the property—the California Trona Company—and obtain possession of the property. At that time—1910—the Foreign Mines company held only 10% of the Trona company's stock; the control not being acquired until 1911, as already stated. But this indirect attempt to force the position failed; the manager of the Foreign Mines company rejected the proposal indignantly. For several years thereafter the Lee locators made a pretense of doing assessment work, coming in conflict with the representative of the U. S. Court, which then had possession of the property on the appointment of a receiver in December 1909. This episode was known at the time as the 'Trona war,' and enabled the daily press to publish a lot of piffle. Only one shot was fired, and that in error. The quarrel did not come to trial then, the contestants expecting to be bought out; in fact, it has been testified that \$180,000 was offered by the Foreign Mines people, but it was refused, fortunately for them. Suit was finally started when the Trona company applied for patent in 1912, but the attempt to adverse was dismissed. Then a suit to quiet title was brought in the Superior Court of San Bernardino county and it is this suit that was decided on September 11 in favor of the defendants, the California Trona Company and others. The decision is sweeping and amounts to an affirmation of title, subject to the decree of the Patent Office, which still has to pass on the validity of the locations.

Potash had been discovered originally by Mr. Whitman Symmes in 1898, but there being no market for that salt, the existence of it in the Searles Lake deposit was ignored until 1912, when the fact was established and given publicity by the U. S. Geological Survey. The War, of course, has enhanced the value of the potash by stopping importation of the products formerly exported from Germany by the Kali syndicate. A plant to extract potash from the Searles Lake salts has been built at San Pedro, near Los Angeles, and we are informed that potassium chloride is being produced in a small way, with expectations of increasing the output shortly.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Basic Lining

The Editor:

Sir—I am surprised that you would allow your paper to print such an incorrect statement as that on page 426 of your issue of September 16:

"Probably the first attempt to use a converter lined with basic material was that by the late Charles F. Shelly at Cananea in 1907. He gave up the trial as impracticable. Some months later, Messrs. Smith and Pierce proved the basic lining a success at Baltimore and Garfield."

If you will look at a copy of the *Mining Journal* for March 24, 1906, you will see a description and report of the operation of the basic-lined converter, lined with magnesite brick, from August 18, 1905, to February 21, 1906. Mr. Baggageley was the first man to successfully smelt ores direct in a bath of molten matte in a basic-lined converter. He had no water-concentrator. He convinced the Guggenheims of this only when he told them to go to the books of the Nichols Chemical Co. and look at their books showing the shipments for eight months from a plant that had no water-concentrator. Smith and Pierce tried out the process at the Baltimore converter and then sent a lawyer from Baltimore to offer \$5000 for two of Mr. Baggageley's patents, then owned by the East Butte. The ignorant officers of the old Pitts-mont company here telegraphed to Col. Paine for advice. He consulted by telephone with the Nicholas Chemical Co. and they told him to ask \$25,000. Col. Paine asked \$20,000 and the lawyer paid it. Smith and Pierce in that first year collected a quarter of a million dollars on the infringement of those two patents. Sixteen others were being infringed at that time, but were all being ignored and unprotected by the company to which Mr. Baggageley assigned them. He bought the Pittsburgh & Montana property in the flats of Butte, because he said there was pay-ore there if you went deep enough for it. The mining world and the Government geologists said he was wrong. Look at the reports of the East Butte today and see who was right. And they are only at the top of their rich ore now. Mr. Baggageley was not ignorant, like your writer, of all previous trials of smelting in this way, but wrote a complete history of it, and its failures, and why each man failed. Copper was being produced in Butte in 1906 at from 7.57 cents to 9.69 cents. Mr. Baggageley produced it from lean ores from 4.84 cents to 5.71 cents. This was in 1905 and 1906, and your paper dared to print that the first successful trial

was in 1907. You should be more familiar with the history of copper smelting.

EFFIE I. BAGGAGELEY.

Pittsburg, September 22.

[Mrs. Baggageley will find, by reference to the offending article, that the statement to which she objects was contained in an article published by the American Institute of Mining Engineers and abstracted by one of our staff for publication in our paper. The blunder, however inexcusable in the first instance, should never have been made in our pages, for Ralph Baggageley was well known to the present writer and so was his work in connection with the introduction of the basic lining. In regard to the Pittsburgh & Montana property, the last report made by the present writer, in 1902, before he ceased to practice as a mining engineer, on becoming editor of the paper at New York, was a report on the ground to which Mrs. Baggageley refers. He advised Mr. Baggageley against the venture, telling him that "the ante was too big for the game," that is, the preliminary expenditure, in exploration, development, and equipment was not justified by the evidence of richness. It would be a pleasure to the present writer to learn, now or at any future time, that this part of the Butte district had proved the scene of profitable mining.—EDITOR.]

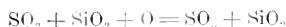
A Patent-Office Joke

The Editor:

Sir—My susceptibilities were greatly agitated by a recent patent (No. 1,185,902) that filtered into a (Royal S.) Handy beaker on June 6, 1916, and to which my attention was recently directed in your columns. Evidently an Idaho school-boy lost his elementary chemistry, for the chemical tutor in Washington passed, with a mark 100, the following chemical equation:

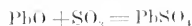


I object. It is I. Oxygen (O_2), and not my *alter ego*, Ozone (O_3) that attaches itself to PbS. I do not love galena, but when driven to the attack by heat of chemical emotion, I cling to her with a powerful embrace, and when I do my dusky bride turns pale. My *alter ego* is never known above 300 C. as his soul then becomes mine.



What a shock! SO_2 is an old affinity of mine, but she is coy and insists on proper nuptials. Oft I ask her, but

never may I wed her except in the presence of a duly ordained clergyman. My relative, Nitric Oxide, and old father Platinum Black are our favorites. There are others. Silica is also a relative of mine, but alas! he is an insoluble enigma.



Hurrah for my children! Right you are!



Once more unto the breach, dear *alter ego*. Show yourself brave and stick to your trenches in spite of the heat of the attack. Glory be to you for your discovery of native FeS in quantity. My find is usually FeS₂.



Shades of Dalton and Lavoisier! What have we here? The sign of inequality?

When two makes three

And three makes four,

Take some of me

And faint no more.

OXYGEN.

Denver, September 19.

Tax on Mine Products in British Columbia

[The following exchange of letters is self-explanatory.—EDITOR.]

Mr. Wm. Fleet Robertson,
Provincial Mineralogist,
Victoria, B. C.

Dear Sir:

We have heard that your Government is levying taxes upon net proceeds of mines as a War measure. Can you give me any information regarding this matter? I know that the fact that such taxes have been levied, or are in prospect, is causing American mining men to hesitate in making any investments in British Columbia.

Yours very truly,

G. W. SMITH.

Butte, August 26.

G. W. Smith, Esq.,
Butte, Montana.
Dear Sir:

Replying to yours of the 26th inst., there has been a lot of talk on your side of the line regarding the so-called War tax, and I have had to answer innumerable inquiries.

The Act assented to May 18, 1916—is known as "The Business Profits War Tax Act, 1916," and is being administered in the Western Provinces by Mr. A. G. McCandless, 241 Winch Bldg., Vancouver, from whom you can obtain copies of the Act and any official information desired. Briefly, the following is the substance of the Act: A company is allowed to make 7% profit and an individual 10% clear of taxation. From the gross profit deductions are allowed for working expenses, deprecia-

tion, exhaustion of ore reserves in a mine, etc., etc. In other words, profits are absolute dividends. For profits over amounts stated the tax is 25% of such excess. For example, a company making a clear profit of 11% (7% plus 4%) pays a tax of 1%. The Act is a War measure, and is for the duration of the War and a short time afterward.

I think you will agree with me that there is nothing so very dreadful in all this, and if any company is not prepared to pay this amount out of profits made from Canadian mines or business—to assist in this War—then most heartily we do not want them or their money in this country.

I am, yours very truly,

W. F. ROBERTSON,
Provincial Mineralogist.

Victoria, B. C., August 29.

Field-Signaling

The Editor:

Sir—I have noticed with interest the article in your issue of September 16, with reference to field-signals, and believe your correspondent would be interested in the more complete and well established system of semaphore signals used regularly in the United States Navy for communicating from ship to ship.

The system that your correspondent proposes has the disadvantage, in signaling letters after J in the alphabet, that two symbols must be used instead of one. In the semaphore alphabet, which is formed by different positions of the hands and arms, this is not necessary. The semaphore system is completely worked out with a series of secondary meanings for the different letters. For example, K equals 'No' or negative; P equals affirmative or 'Yes'; L equals preparatory; O is a question or interrogatory, and so forth.

No doubt, many engineers and miners are acquainted with this code, which has been in general use for a long time. Many of the Navy signals are given in the form of a three-letter code and something of this sort could be worked up for field use by surveyors and engineers. The hand-signals can be seen at a considerable distance, and if long signals are to be given at great distances, a pair of flags about 15 inches square on 18-in. sticks will be found a great assistance. Those used in the Navy are half red and half yellow, divided diagonally across the field. This system is much more rapid than the ordinary Morse wig wag, as but one position of the hands is required to form a complete letter.

A CIVILIAN NAVAL VOLUNTEER.

Chicago, September 20.

DREDGING at Pato, Colombia, the Oroville company saved gold worth \$21,372 from 85,942 cu. yd. of gravel in 18 days during August.

GOLD OUTPUT of the Mysore mine, the largest in India, amounted to \$343,000 from 26,642 tons of ore in August.

Concreting the Sacramento Shaft at Bisbee

By G. S.

INTRODUCTION. It became necessary in 1915 to re-timber, or otherwise secure, a part of the Sacramento shaft, the main hoisting-shaft of the Copper Queen Consolidated Mining Co. Re-timbering would cost less, but a concrete lining would eliminate fire-risk and cut repairs to a minimum.

Either operation, re-timbering or lining with concrete, was complicated by the necessity of hoisting nearly all the ore mined in the Copper Queen mine through this shaft. It was estimated that the required production could be made by hoisting 14 hours per day, leaving 10 hours for work in the shaft.

A general plan and comparative estimates of cost were prepared, and in March 1915, twenty-five feet of shaft was concreted to test the method and estimate of cost. Certain experiments were made at the time to secure information on a few details of operation.

After it was decided to concrete the shaft, a quarry for crushed rock and sand was opened, storage-bins at the shaft were built and forms were constructed. The first 5-ft. section of concrete was poured on October 17, 1915, and the collar set on July 30, 1916. Since then, a ladder-way and a new set of guides for the skip-compartments have been put in, with regard to convenience rather than speed, and the work was finally completed on September 3, 1916.

GENERAL PLAN. A crushing-plant at the quarry produced both coarse rock and the fine material used as sand.

There is no railroad-track above the Sacramento shaft. The sand and rock were brought to the shaft by railroad, and there elevated to storage-bins. It was trammed to the concrete-mixer through an adit-level 71 ft. below the shaft-collar. The mixer was placed below the adit-level, in a set adjoining the fifth or pipe-compartment of the shaft. After mixing, the concrete was dropped into a hopper and through a 4-in. pipe in the fifth compartment to the forms below.

The lining was made at three different points alternately to give time for the concrete to set properly before the forms were stripped. This was to permit single sets of forms to be used, as was found most convenient.

The skips and cages were fitted with top decks to work from, and additional temporary bonnets were clamped to the ropes above for safety. When the timbers were removed, they were dropped into the skips or lashed on the cages, and taken to the surface when convenient. This was believed to be safe with the powerful hoisting-engines operating them, and avoided the use of working-stages, which would have taken too much time to put in and remove.

QUARRY AND CRUSHING PLANT. In crushing, a con-

siderable quantity of sandy material is produced, which is customarily used to replace a part of the necessary sand. It was believed that by separating with a coarser screen and installing a set of rolls, sufficient sand could be crushed more cheaply than it could be obtained otherwise. Samples of rock crushed through $\frac{1}{2}$ -inch screen gave satisfactory results under test. Since it was necessary to open a quarry and provide a crusher, screen, and bins, only the addition of an elevator and rolls were needed to produce sand as well. A 10 by 20-in. jaw-crusher and a set of 15 by 26-in. rolls were obtained from the smelter, and a small plant with elevator and trommel erected.

Power was furnished by a 50-hp. induction motor.

The coarse material having to pass the 4-in. pipe, was reduced to a $1\frac{1}{2}$ -in. ring. Material passing a $1\frac{1}{2}$ -in. ring was sent to the rolls. This did not provide sufficient fine, so holes were increased in number and reamed out to 1 inch. A third product was made passing a $1\frac{1}{4}$ -in. ring. Since another elevator would have been required to return the oversize to the rolls, the fine was used as it came. This product contained a good many coarse pieces. It was not convenient to re-screen and send the oversize to the middling-bin, so a greater quantity of fine was used to give sufficient sand. The only difficulty was when mixing small batches, as, for instance, for the concrete beams. Then there was apt to be segregation, and the mixture was uneven. For this purpose, it was screened and the oversize thrown into the middling. In batches of ordinary size for the shaft, no difficulty was encountered.

The quarry was started where rock comes to the surface, and a good working-face was soon obtained. Drilling was done by jack-hammer, one machine breaking all the rock required. Only clean rock was sent to the crusher, earthy material being left on the floor of the quarry. A track, 41-in. gauge, of 16-lb. rails was laid from the crushing-plant to the quarry, and branched to control the whole face. The rock-cars were built broad and low, for convenience in loading. They were dumped by raising the tail end by a compressed-air cylinder.

The rock from the car dropped five feet to the crusher, where there was only storage for a carload or so. The crushed rock dropped into the boot of a bucket-elevator, which raised it and dumped it into a revolving trommel. The fine material from the first section dropped directly to the rolls below, and from them into the fine-bin. The second section delivered the middling product into the second bin, and the third section the coarse aggregate into the third bin. The oversize was returned by a chute to the crusher and continued the circuit.

TRANSPORTATION. The concrete material was loaded

from the bins into Rodgers ballast cars and switched to the Sacramento shaft.

STORAGE BINS. The railroad track at the Sacramento shaft is too low to dump the cars into storage-bins from which it could be delivered by gravity to the mixer. A spur was therefore laid over a shallow hopper-bottom bin, holding a carload of rock or sand. A belt-conveyor under the receiving-bin carried it to the foot of an elevator, which lifted it to the top of the storage-bins and delivered it into one of the three compartments. The bins were constructed almost entirely of nine-timbers, framed for ordinary purposes and bolted together. When it is taken down, the timber will have its original value for use in the mine.

The chutes from the storage-bins form measuring-pockets for a batch of concrete. The proportions were determined by customary methods of experiment.

Opposite the bins, a small house was built beside the railroad track for cement storage, and sufficient cement for a section was taken on trucks to the mixer-station immediately before use.

THE MIXER was a half-yard Ransome machine, and was set just below the adit-level, in an excavation made for the purpose facing the fifth compartment of the shaft, with the loading-hopper flush with the floor. After mixing, the concrete was discharged into a hopper that formed the whole bottom of the fifth compartment, and connected with the 4-in. pipe. The sides of the hopper were built at 40° from the horizontal, which facilitated feeding better than a steeper angle.

The water was measured in a tub with a quick-discharge valve.

CONCRETE PIPE-LINE. It was impossible to put the concrete line in any one of the central compartments, since they were in constant use; therefore it was placed in the fifth compartment of the shaft. It was inserted at once to the bottom of the shaft, and shortened as the shaft was finished, from the bottom upward. The line was made of 4-in. standard pipe, threaded deep enough to let the end come clear through the flange, and all lengths were faced in a lathe after flanging, to an exact length of 10 ft. The flush joints left no irregularities on the inside surface to start erosion, and by making all pipe lengths 10 ft., any piece could be replaced without trouble. At the upper points of work, a length of pipe was taken out to attach the elbow, and if necessary, a 5-ft. length was slipped in, to deliver the concrete at the proper point above the form.

The shaft was so long that concrete could not be spouted to the forms at the opposite end without great difficulty in handling the spouts. An elbow was therefore attached to the lower end of the column, and the concrete shot to the form by compressed air delivered at the back of the elbow. In turning 90°, the elbow expanded from four to six inches in diameter, so that there would be little chance of clogging. Short pieces of 6-in. pipe of proper length were attached to the elbow to carry the concrete to the other end of the shaft. At the end of the short pipes, a 45° malleable elbow was attached,

loose on its threads, and a short piece of 8-in. galvanized iron pipe was slipped loosely over it and the short nipple in the elbow. By turning the elbow on its threads, and using the loose fit between the 6 and 8-in. pipe for further change in angle, it was possible to deliver the concrete wherever desired.

It was planned to begin concreting in the fifth compartment, which contains the concrete column, and build out to the far end, but this was changed afterward, and work begun in the skip-compartments, in order that they might be freed more quickly for hoisting ore, which often began before the other part of the shaft was finished.

It was at first thought necessary to discharge the concrete in an open bucket below the straight pipe, as at the Old Dominion and Junction shafts, and let it overflow into a short length of pipe down to the compressed-air elbow close above the forms, for fear of clogging at the elbow and building up in the vertical pipe, but it was not needed, and eliminated a great obstacle to rapid work. The first few rounds of the trial section were poured with the bucket, but in the last, the elbow was attached to the column direct. The first elbows were cast of manganese-steel, but wore rapidly. Later, when others of plain cast-iron were used, forged patches, which lasted a long time, were bolted over the hole when formed, which was always straight under the vertical pipe. In all, six elbows were used. The column lasted well. The sections removed at the lower end were used to replace others above, that were worn out. Sixty-seven 10-ft. lengths of new pipe were required in addition to the original equipment. Much of the column is in fair condition still.

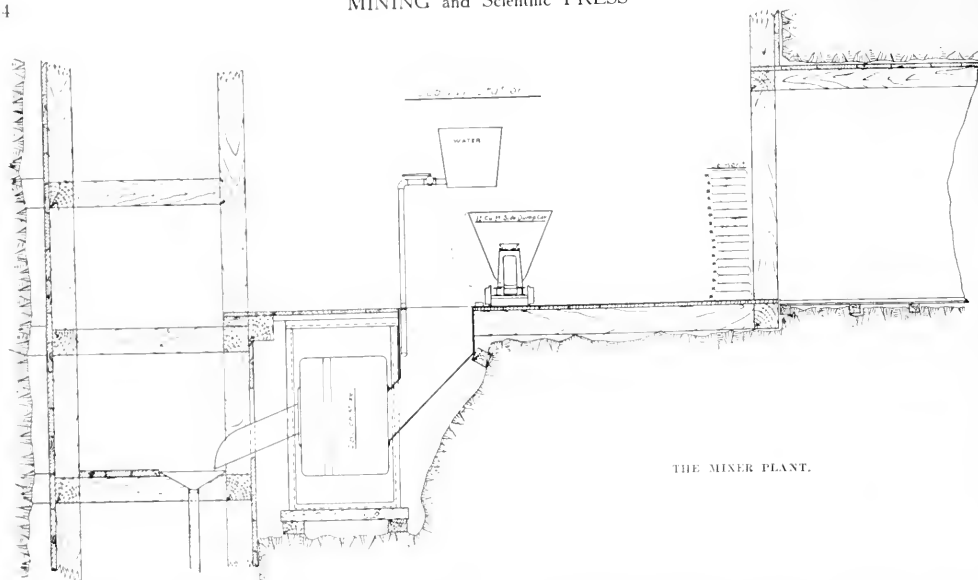
FORMS. The shaft has five compartments; two for skips, two for cages, and one for air-columns, power-cables, and ladders. The skip-compartments are separated from each other and from the cage-compartments by solid walls of concrete 10-in. thick, pierced by windows for access to them and for ventilation. These are placed in every alternate 5-ft. section, and are closely planked between the adjoining cage and skip compartments, but are left open between the skip-compartments, to permit air to pass the skips on its way to the ventilating fan on the 1600-ft. level.

The forms were the most original and important factor of the operation.

It was essential that they should be self-supporting, outside of the space required for cage or skip, and it must be possible to take them down and re-set them quickly. So much time would have been required to remove and re-set the guides that it was desired to leave them in place. These requirements led through several stages to the final design shown in the photograph and drawings.

The new shaft is six inches wider than the old, to allow the forms to be set back far enough under the wall-plates to provide for the thickness of the forms and bracing.

It was necessary to use the shaft so quickly after the



THE MIXER PLANT.

concrete was poured that it was thought best to cast reinforced concrete beams to which the guides could be attached. These were built into the partitions of the skip-compartments, but between the other compartments they stood open across the shaft, with their ends only imbedded in the concrete walls, and formed the whole support of the guides. They were held so strongly by the heavy mass of unset concrete that the far from passing skips only settled them more firmly into place, and the initial 'set' of the concrete was not broken.

The forms in the skip-compartments are in two halves, each made of a large side-plate and two hinged wing-plates that extend to the guides. They are tied to each other by iron straps passing behind the guides, to which they are fastened by counter-sunk screws; and to prevent their shifting, nails are driven through holes in the straps into the guides after they are lined up. Forms in adjoining compartments are tied together by bolts passing through pipes cast in the partition-walls, which serve to space the wing-plates properly.

The cage-compartment forms are somewhat different. Similar side-plates are used, but there are no wing-plates, and they are braced apart by angle irons spiked to the guides, which reach across the shaft in the 10-in. space below the reinforced concrete dividers. There are no concrete partitions, and the side-plates in adjoining compartments are connected by narrow hinged plates which block off the concrete, but permit it to project $2\frac{1}{2}$ in. in vertical columns under the reinforced concrete dividers, as additional supports for them.

The end form is composed of three large plates attached by hinges. The side plates have projections to core out slots in the walls, in which planks or timbers may be set to support platforms and ladders, pipes or power cables. The end plate was built in two parts, afterward riveted together, to get it behind the pipes and cables already in the shaft.

The forms are 5 ft. 9 in. high, and overlap the 5-ft. section of concrete by 9 in. Bolts, or bent iron rods threaded, project through properly spaced holes in the forms $7\frac{1}{2}$ in. below the top, and are imbedded in the concrete when it is poured. When the forms are stripped and raised, the short ends projecting from the concrete fit into corresponding holes 5 ft. lower in the plates and $1\frac{1}{2}$ in. above the bottom. Thus, when raised, they are supported and held firmly at the bottom, where the greatest pressure from the concrete exists. The upper part is brought into alignment by attachment to the guides. They are therefore self-aligning, and require no tedious adjustment to plumb-lines swinging in the shaft.

It will be noted that all hinges are made with tapered pins that may be driven entirely out, thus disconnecting the plates, and that the hinges which are situated in the beveled corners are made so that in the skip-compartments the narrow wing-plates, in revolving, turn directly away from the face of concrete, and cannot bind. The side-plates then have ample end-clearance, and can be moved straight out also without possibility of binding.

The form in each compartment could be stripped and raised independently of the others. They were only tied together after being put in place and aligned by attachment to the guides.

The forms were made of heavy plate with accurately fitting hinges, and being very stiff, and firmly held at the bottom by the bolts cast in the walls, resist the pressure of the concrete without twisting or throwing too heavy a strain on the guides. They were made with great accuracy, all holes being drilled to template. The hinges were of beveled cast-iron, and were machined to standard by the use of jigs and templates, and the taper-line pins were turned in a lathe. This unusual care was taken so that parts could be replaced without special fitting.

With the exception of part of one set, which stood in the shaft from March until October, no new forms were needed, and with the exception of the forms in the skip-compartments, which are more or less battered by spillage from the skips, they are still serviceable.

Chute-mouths were passed by blocking off the concrete from the sections to be left open.

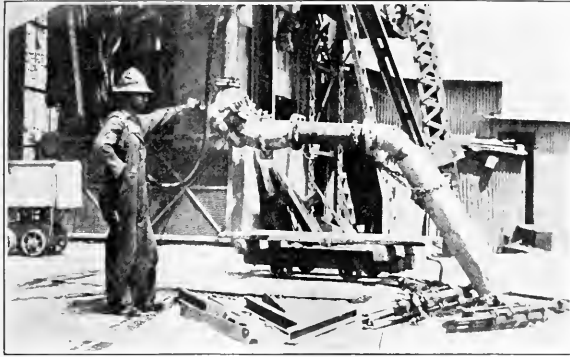
At the stations, partition-walls were cast in between the cage-compartments and between the cage and pipe

was placed upon them to keep the shaft straight. Then, four to six sets of special hangers were inserted at each point of work to hold the timbers securely above the break between timbers and concrete. These were made of $\frac{3}{4}$ -in. square bars, with a turnbuckle in the middle. The ends were bent, and reaching around the wall-plates, clamped them together. This was much more rapid than if customary hangers were used.

Each cage or skip was equipped with a complete outfit of tools, etc. These consisted of two pairs of half-ton chain-blocks for each compartment, axes, saws, wrenches, tamping-bars, grease for the forms, rope-lashing, etc.

The shaft was divided into three nearly equal sections, and the starting-points were selected where the ground broke large, with a smaller section below. After hardening, the concrete would therefore wedge itself against the ground and support itself. In each case, it was necessary to make special timber-supports for the wet concrete, which made the first sections rather slow.

In beginning, each form was set with the top about two feet below the bottom of a set of timber. This was to leave only a short space of ground unprotected in the interval before the next section was poured. Owing to changes in form-setting when working past levels, this did not always remain the same, but it was found later that considerable space could be left without danger. When set as originally planned, the guides were unsupported for only a very short distance, and the attachment to the concrete beams was so close to the set above that there was no unusual strain on the guides, and little



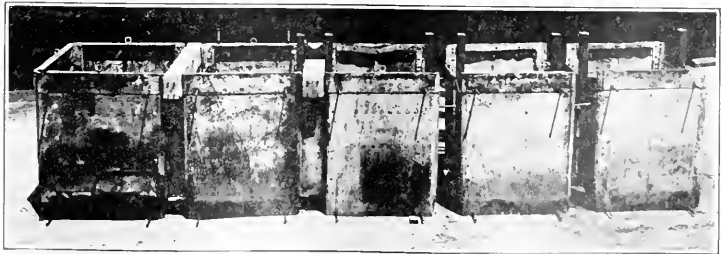
ELBOW AND DISCHARGE-PIPE.

compartments. The edges of these walls facing the stations were formed of reinforced concrete pillars 5 in. wider than the partitions and 10 in. deep.

CONCRETE DIVIDERS AND GUIDE ATTACHMENTS. The reinforced cast beams for dividers were 10 by 10-in. sections and 6 ft. 2 in. long. They were cast in steel forms near the collar of the shaft. The concrete was mixed in a 4-cu. ft. power-mixer. After standing for a few days on the casting-plates, they were lifted by a small hand-derrick and stored in piles for three to four weeks, to season before use.

The guides were bolted to cast-steel brackets, which were fastened to the concrete beams by bolts passing through them, and can be replaced if damaged. Guide-bolts can also be changed easily, and there is sufficient height in the slot to allow for errors in boring guides or variations in the height of the beam. No attempt was made to have the ends of the guides meet on the brackets. Splice-plates were strapped on the back to hold temporarily until they could be permanently secured. Bent cover-plates were placed over the brackets to make pockets in the concrete, so that guide-bolts or the brackets themselves could be replaced.

METHOD OF WORK. Before concreting was begun, the guides were aligned carefully, since entire dependence



FORMS SET UP, SHOWING CONCRETE DIVIDERS AND ANCHOR-BOLTS.

on the green concrete.

The operation soon fell into a routine, which was not altered except in speed. Work began at 7:00 a.m. The skips and cages were then loaded with tools and current supplies, including a set of reinforced concrete beams. Upon reaching the point to be concreted, the hangers were taken out, the guides disconnected from the dividers, the wall-plates cut in three pieces and dropped away from the set above, after which the whole set of timbers came apart easily and was dropped into the skips or piled on the cages and lashed securely. The shaft was then cleared of loose rock and the 'muck'

dropped into the skips or stored on the cages; line material went down the shaft. In some cases, the ground was not sound, and lacing was needed to hold it temporarily in place. This was usually cast into the concrete and left. It had to be held such a short time that loose ground was easily handled, although not so rapidly.

As soon as the timbers were removed and the faces cleaned, chain-blocks were hung above and the concrete dividers slung between the guides close under the timber dividers, and lashed to them with ropes. Each set of blocks was then hung over one of the large side-plates of the forms, the slack taken up, all bolts in the forms removed and the forms themselves loosened. They were then hoisted 5 ft., slipped over the upper bolts projecting from the concrete and fastened loosely. The tie-plates behind the guides were then attached and spiked, to centre the two halves of the form. The spacing-bolts between adjoining forms were put in and the forms connected from end to end of the shaft. If there appeared to be a slight tendency to get out of square or line, they were wedged into position from a convenient point of ground, and all bolts were tightened. Other wedges were put in against the ground, and between guides and skips or cages, to take up the pressure of the fresh concrete, which might spring them out of line.

The surface of the forms against the concrete were then painted with a light grease to prevent their sticking, and they were ready for the pour.

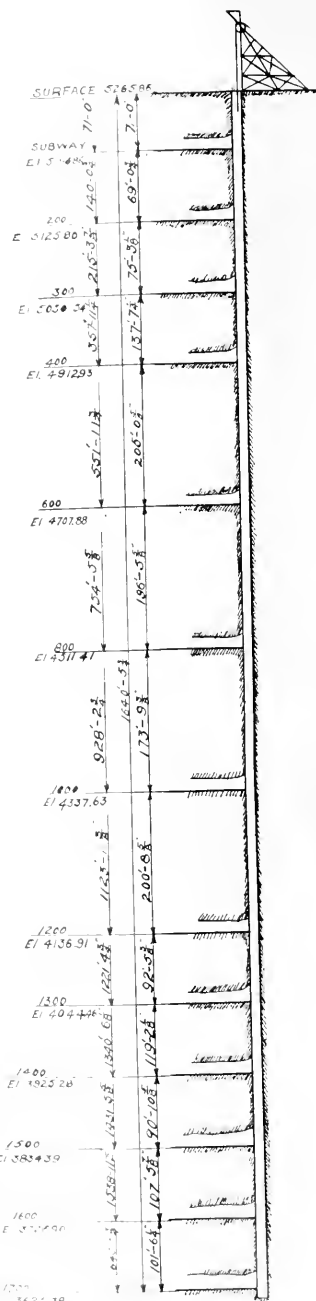
When the forms were first put down, it was found that the bottom part of the form, which overlapped the concrete when raised to a new position, could not be put in without a great deal of trouble. A form taken away from a face of concrete cannot be replaced in its original position, and the slight irregularity between the bottom and top of the form exaggerated the difficulty. By riveting a $\frac{1}{2}$ -in. plate 10 in. high around the top, a sufficient recess was cast to give plenty of clearance, and made changes rapid.

During the month of June, it took about 81 minutes to take out the timbers, and $47\frac{1}{2}$ minutes to raise the forms and connect them ready for concreting.

The elbow was then attached to the concrete column, the 6-in. pipe laid across the shaft to the skip-compartments, and concrete pouring began from that end. The first one or two batches of concrete were made richer and wetter than the rest. As the concrete rose nearly to the top of the forms, the reinforced concrete beams were dropped in place and attached to the guides by means of the brackets. This lined them up with the guides, and the concrete was then tamped around them closely and brought up flush with the top of the forms.

The average thickness of the side walls was about 15 in. The thin section and all partition walls were reinforced, and reinforcing bars were laid across the ends of the concrete dividers to tie them into the side-walls.

As soon as the skip-compartments were finished, the opening between the skip and cage compartments was planked up temporarily, and if it was a set having a window, the permanent planks were put in also. The battens removed from the set taken out were inserted



Station Elevations

THE SHAFT STATION ELEVATIONS.

above and the skip-compartments were ready for hoisting ore. The other compartments were finished later, and the pipe connected for the next section.

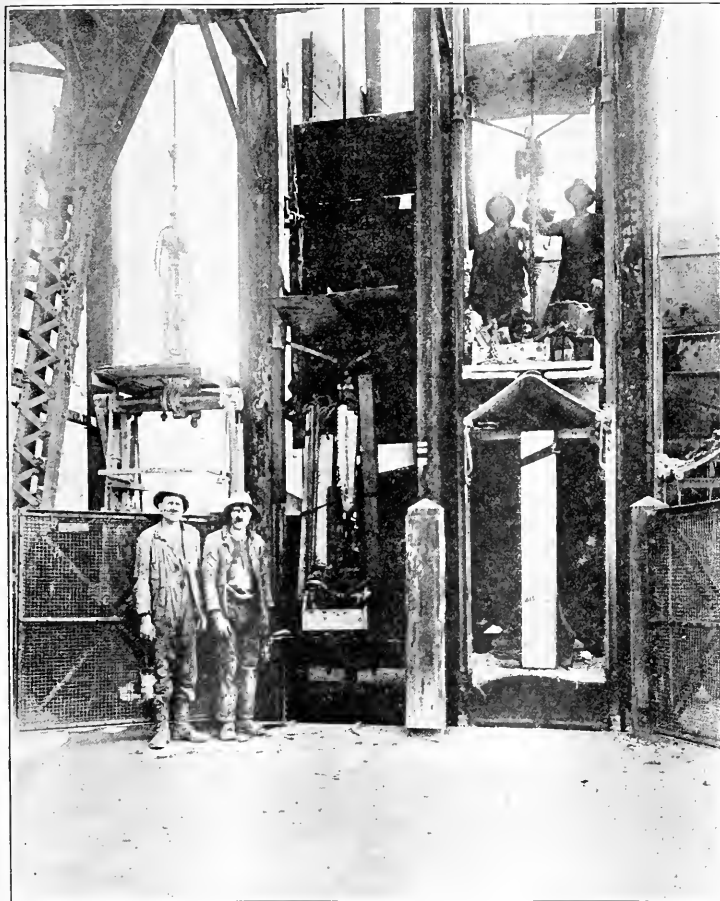
A convenient time was used for going to the top for 'lunch,' after the forms were set, for instance, or in some cases, after the round was finished. The timbers were then taken from the cages and skips. When com-

The mixture was rather rich, however, and the concrete was not injured.

The men employed in the shaft were 12 in number; 2 in each compartment, one pipe-man and one foreman. Since every set was, in its essentials, like every other, and each pair worked in the same compartment continually, they became extremely expert in the work, and in co-

operating to make progress. Some work a little out of the routine had to be done in changing concrete-pipe, compressed-air connections, or the pipes and cables in the shaft. This was done whenever convenient, ordinarily during the latter part of the shift. An electrician was usually in attendance.

CONCRETE MIXING. The mixing, which includes bringing the cement and aggregate from storage to mixer, occupied a crew of eight men. One man measured rock and sand into the hoppers; four men trammed it to the mixer; one man assisted in dumping the cars and measured the cement into the hopper; another tripped the materials into the mixer and measured the water, and a foreman fed the mixed concrete into the hopper and 4-in. pipe. This required considerable care. Mixing began when a red signal lamp was lighted from below, and stopped when it was turned off. After the section was poured, the concrete mixer and pipe were washed out with water, so that they might be clear for the next day. When not mixing concrete, the men cast reinforced dividers, removed timbers, and cut it to lengths for use underground. Others



CAGES EQUIPPED FOR WORK. THE PUMP ATTACHED TO THE CABLE.

ing up after finishing a round, the boxes containing bolts, tools, etc., were at once overhauled to see that the equipment was complete for the next section.

The 70-ft. section above the adit-level was concreted by discharging the concrete into a car on the nearest cage, and hoisting it to the collar. From there, it was spouted down to the forms.

It was at first expected that the concrete would stand about 64 hours before the forms were stripped, but when greater speed was made, a number of forms were stripped in less time, and during the latter part of the time, a few forms stood only about 20 hours after pouring.

unloaded cars of sand or rock and elevated it to the bins, trammed cement to the mixing station, or assisted in operating the ore-conveyors.

PROGRESS. It was originally estimated that the maximum time for putting in a section would be ten hours. This time dropped at once to eight, and as the men became more accustomed to the work, it was still further reduced, until it became a question of how to use the rest of the shift to advantage. Additional production was desired, and hoisting usually began as soon as the skip-compartments were free. The men from the skip-compartments loaded the skips, operated the belt-con-

voyers, etc. The time occupied in doing effective work outside the shaft was charged to that work and not to the shaft. Those men not occupied in loading skips or operating the conveyor-plant, made what preparations were possible for the next round. Before long, the time was shortened so much that it was possible occasionally to concrete two sections in eight hours. This first occurred on November 14. Later, two sections in eight hours was frequent, and in June, 260 ft. of shaft was lined in 30 days, and 64,545 tons of ore hoisted in the same time. On July 3, three rounds were put in.

PROGRESS TABLE

1915	Days worked	Number of feet	Dry tonnage hoisted
October	11	55	27,844
November	22	135	63,491
December	12	90	74,313
1916			
January	19	110	67,000
February	29	150	66,166
March	31	165	75,190
April	30	200	63,820
May	30	250	69,247
June	30	260	64,545
July	27	205	62,722

An accurate log was kept of all shaft-work beginning on November 6, 1915, and covering 1540 ft. of shaft. During this period, the average time required to complete a cycle of operations in putting in a 5-ft. section was 6 hours 14 minutes. In June 1916, it only took 4 hours 31 minutes for the average set.

	November 6 to July 30, minutes	June, minutes
Loading tools and cleaning shaft.....	30	19.2
Removing timbers	98	80.9
Raising and setting forms	84	47.4
Connecting concrete pipe	28	27.3
Mixing and pouring concrete.....	78	60.0
Unloading cages and cleaning tools.....	17	14.8
Miscellaneous delays	9	3.4
Lunch	30	17.3
	374	270.8

COST OF CONCRETING SACRAMENTO SHAFT

	Total cost	Cost per foot of shaft
Miscellaneous preparatory expense:		
Making platforms, etc., for cages and skips	\$ 252.79	
Changing power-cables, electric lights, etc.	263.00	
Supply-house at shaft.....	120.05	
Miscellaneous	527.68	
	\$1,193.52	\$0.72554
Aligning guides	557.55	0.33893
Routine labor in shaft		
Removing timbers	\$5,063.08	
Raising and setting forms.....	4,998.21	
Pouring concrete (\$9.686 per yd.)	1,303.65	
Repairing and changing concrete columns and other pipe-work.	2,318.22	
Protection and changing of power cables	1,655.43	
	18,338.59	11.1481
Concrete	12,796.47	26.016
Concrete dividers	3,663.32	2.227

	Total cost	Cost per foot of shaft
Miscellaneous supplies:		
Reinforcing bars	\$1,150.25	
Guide-brackets and covers.....	3,024.77	
Bolts	718.02	
Angles for partition-walls.....	461.91	
Distance-plates	482.24	
Miscellaneous	3,512.57	
	\$9,349.76	\$5.684

New guides, ladders, etc:

Labor	\$1,527.91	
Timber	675.90	
	2,203.81	1.339
Hoisting engineers	1,861.15	1.131
Supervision	3,372.10	2.050
Accident compensation	88.53	0.053

Total	\$83,424.80	\$50.712
Credit for timber delivered to mine department	2,801.62	1.703

Net cost	\$80,623.18	\$49.009
Cost of opening quarry and equipment of crushing plant	5,666.18	

CONCRETE

	Yards of material	Yards of concrete in place	Cost per yard of material	Cost per yard of concrete in place
Rock and sand				
Quarrying and crushing 7,800	6,195		\$0.8978	\$1.1204
Transportation and elevation at storage-bins.....	7,800	6,195	0.1729	0.2177
Cost of storage-bins.....	7,800	6,195	0.2713	0.3416
	7,800	6,195	\$1.3420	\$1.6898
Sand and rock bought for experimental section...	93	75	1.641	2.035
	7,893	6,270	\$1.346	\$1.6939
Cement		21,559.98		3.4386
				\$5.1325
Mixing		3,363.69		0.5594
Concrete column, elbows, air-lines, etc.		2,435.79		0.3885
Forms		4,672.66		0.7452

Cost per yard of concrete delivered at forms*

\$6.8256

*There was no absolute method of measuring the concrete in place. It was estimated by casting several batches composed of the regular mixture of rock, sand and cement, into a box, and measuring the contents of the mass after it was set. The mixer-charge was estimated to make 11 cu. ft. of concrete in place.

REINFORCED CONCRETE DIVIDERS

	Total cost	Per cu. yd. concrete
Labor of mixing	\$1,168.54	\$5.02
Rock and sand	393.73	1.69
Cement	962.82	4.13
Reinforcing	727.13	3.12
Pipes for bolt holes	185.55	0.80
Forms	90.00	0.39
Miscellaneous supplies	135.55	0.58
	\$3,663.32	\$15.72

The costs include all items chargeable to this work. As the cages and skips made only 3 trips per round, no charge was made for power. The engineer only was

charged to the work, since it is necessary to have one hoisting-engineer continually at his post.

Estimates were made on a scale that would have paid the shaftmen \$4.50 per shift. The work was done, however, on a much higher scale, the average rates prevailing being given herewith:

Shaftmen	\$5.47
Pipemen	6.22
Electricians	5.22
Mexicans at quarry	2.40
Mexicans mixing concrete, etc.....	2.90

MEN ASSOCIATED WITH THE CONCRETING OF SACRAMENTO SHAFT
George Mieyr (master mechanic), in charge of all operations.

C. S. Heisler, in charge of quarry and mixing plant.

F. M. Heidelberg, draftsman, designer of forms.

Joe Lutz, in charge of work in shaft.

B. W. Pernel, shaft and pipe man.

William Gunn, in charge of electrical work.

Carl Carlson, Alex Jacobson, Dan Murphy, Charles Mieyr.

Pat Smith, Sam Granquist, W. B. Hughes, George Kelly, W. R.

Drew, John Johnson, shaftmen.

Frank Craig, in charge of mixing crew.

There were no changes in the personnel from the beginning of the work, and it was an excellent example of what can be accomplished with team-work and goodwill.

The Separation of Galena From Blende by the Horwood Process of Flotation

By Allan D. Rain

*The Horwood process bears the name of its originator, E. J. Horwood, assistant general manager for the Broken Hill Proprietary Company, at Broken Hill, Australia. Briefly, the principle of the process as applied to mixed lead-zinc sulphide ores is that advantage is taken of the different oxidizing temperatures of galena and blende, the galena oxidizing to lead sulphate much quicker, that is, at a much lower temperature than the blende oxidizes to zinc sulphate (given, of course, the ore of a fineness that is necessary for separation of the lead and zinc particles). Such being the case, by judicious roasting of a mixture of these two minerals the lead sulphide can be totally or superficially oxidized to its sulphate under control temperature without affecting the zinc sulphide. By a subsequent flotation operation, the blende may be recovered in the ordinary way and the lead sulphate or the sulphide coated with a film of the sulphate that, not being amenable to flotation, remains as a residue. It may be better, before dealing with the process on a commercial scale, to give a description of the method of making laboratory tests.

PREPARATION OF THE ORE. On all ores treated to date, it has been found that the material must be screened through an 80-mesh sieve. Generally speaking, this ought to be considered the maximum of coarseness, and for close recoveries of either zinc or lead, the finer the material the better for the process.

SULPHATIZATION. The success of the process depends on the manner in which this is done, the object being to preferentially sulphatize the galena, leaving the blende unchanged. By keeping the ore at a low temperature for the first portion of the roast, and then raising the heat toward the latter portion (provided the material is kept freely stirred the whole time) no difficulty will be experienced in the laboratory, in changing the galena and leaving the blende unaltered. It is obvious that at no time during the roast must the temperature be raised

sufficiently high to oxidize the blende. Should this happen, however, the final object of the process will not be defeated, but the resultant zinc loss (due to the solution of any oxidized compounds in the acid used for subsequent flotation) would be increased. The increased quantity of zinc thus lost is directly proportional to the amount of oxidized or sulphatized zinc produced during the roast.

Generally speaking, the temperature to be maintained during the roast should increase from 400°C. at the start to about 500°C. at the end. Some ores require a longer roast than others, the time being dependent on the nature of the sulphides present, and the degree of comminution of the ore. It is not necessary to completely sulphatize the whole of the galena in order to separate it from the blende. The degree to which sulphatization should be carried is to some extent dependent on the size of the ore particles. In order to deaden the galena to flotation it is sufficient to convert the surface of the particles into sulphate, the core of such particles remaining unchanged. The only method of ascertaining definitely when the sulphatization has been carried sufficiently far is to take portions of the roasted ore and make laboratory tests on them, carefully weighing and assaying the products so obtained.

If laboratory tests are made prior to sulphatization on a large scale, and the lead sulphate determined in the sulphatized material, this will afford a simple and rapid method of determining when, in actual practice, the roast has been carried sufficiently far. Then, for example, assuming that in the laboratory the lead sulphide had been sulphatized to the extent of 78%, and that such material gives the desired results, all that is necessary in roasting a bulk lot of ore is to withdraw a sample every quarter of an hour from the furnace and determine its lead sulphate contents, this determination not taking more than a few minutes. For instance, a sample of zinc-lead slime sulphatized in the laboratory over a gas-burner for about two and a half hours was found to

*Abstract from *Copper Topics*, published by the Braden Copper Co., Chile.

contain 73% lead as sulphate; the subsequent separation made on this material yielded approximately an 86% zinc recovery and an 81% lead recovery in zinc and lead concentrates respectively. A small amount of zinc is lost invariably in the subsequent flotation, by reason of the formation of soluble zinc compounds during the roast; but if the roast has been carried out in the correct manner, the quantity of zinc so lost should not amount to more than at most 2 to 3% of the total zinc in the ore.

FLOTATION. Fifty grams of the sulphatized ore is weighed and placed in a 500-cc. cylinder, provided with a stopper. Boiling water is admitted to the 250-cc. mark, then 3 cc. of 95% sulphuric acid (Sp. Gr. 1.8376) and the mass is agitated for a short time. After this, either 0.1 cc. or 0.2 cc. of oleic acid is added, and the whole is then thoroughly shaken by hand. The agitation is continued until the sulphides become thoroughly oiled and float to a large extent. The contents are then transferred to a 16-oz. beaker and the bulk increased with boiling water that has been used to rinse the cylinder. The beaker is then placed on a sand-bath and flotation is produced by heating the bottom of the beaker. A little calcite is added prior to the application of the heat, to prevent the material from lying dead on the bottom and to assist the flotation. During flotation the mass in the beaker is stirred gently with a glass rod in order to hinder the formation of too large clots, which include floured lead sulphate. The concentrate is removed with a spoon from the top of the liquor, the skimming being continued until no more blende floats. The lead remains in the residue as sulphate.

The concentrate resulting from the above first separation is usually dirty; it requires to be re-agitated in a 1% sulphuric acid solution (without the addition of any further oil) and re-floated in a manner similar to the first separation. The float concentrate resulting from this re-agitation is transferred to a tin-can, dried, the oil burned off, and the residue weighed. The residue resulting from the two separations are bulked, transferred to a tin-can, dried, and weighed.

METHOD OF TREATMENT BY ZINC CORPORATION. After a number of successful laboratory demonstrations, trials more closely approaching commercial treatment were made on large parcels, with encouraging results. Almost the first to become interested in this process, besides the originator, E. J. Horwood, was the management of the Zinc Corporation, which had as a by-product a small proportion (roughly 5 to 6% of total concentrate produced) of a mixed lead and zinc slime, for which it could neither secure sale nor devise any means of successful separation. This process was tried as a probable solution of their metallurgical difficulties, and one by which they could separate into salable products this mixed lead-zinc slime-concentrate. This they were stacking with a view to some successful treatment later. The mixed slime concentrate assayed approximately 35% zinc, 16.5% lead, and 25 oz. silver per ton.

A glance at a representative buyer's formula will ex-

plain why this product was unsalable as a zinc concentrate.

Buyer's price on board cars:

$$(Zn - 8)(P - 5\%) + (Pb - 8.5)(30c.) + (Ag - 5 \text{ oz.})$$

$(P' - 2) - R$, where

Zn = % of zinc.

Pb = % of lead.

Ag = oz. silver per ton.

P = average price of zinc over six months following delivery.

P' = average price of silver over six months following delivery.

R is the smelting charge, which is \$24 when the price of spelter is \$84, and increases 72c. per ton for each \$4.80 increase in the average price and decreases 72c. per ton for each \$4.80 decrease in that average price. A penalty of 30c. per unit is imposed for every unit of lead over 8%, but the penalty is never to exceed payment for the silver.

THE STEEL INDUSTRY is expanding. New construction which will be completed during the calendar year will add to the yearly capacity of the Steel Corporation 1,100,000 tons, and 1,500,000 tons to the capacity of independent plants. Projects for construction in 1917 indicate further increases in annual capacity of 1,900,000 and 700,000 tons, respectively, for the Corporation and the independents. Thus, in 1916 and 1917 the capacity of the industry, apparently about 40,000,000 tons per year at present, will be increased about 15%. The last period of new construction of steel plants ended in 1913. To supply raw material for keeping existing steel plants in operation at their present rate, 60 million tons of iron ore must be brought eastward from the mines about Lake Superior. The movement of such an amount of ore in the nine months during which navigation is open on the Great Lakes requires utilization of the ore-carrying fleet to its utmost capacity.

COKE OVENS of the sort that save by-products such as the coal tar which is the raw material of dyes, pharmaceutical preparations, and explosives, were little used in the United States before the European war made them important and profitable. Statistics gathered in another connection by the Bureau of Mines indicate that at the end of 1915 there were thirty-eight active plants of by-product ovens and that these plants are so extensive that they employed two-thirds as many men—13,000—as the old-fashioned bee-hive ovens. The by-product coking plants already built in 1916, or definitely planned, will add about two thousand ovens. Two plants, of 204 ovens apiece, completed in August, will make about 140,000 tons of coke per month.

STEEL WORKERS are now receiving the highest wages known. Iron puddlers receive \$8.80 per ton, and as a day's "turn" is 2½ tons, a puddler is making at the rate of \$22 per day. Hot weather prevents more than 4 days a week being worked, according to *The Iron Age*.

Flotation Concentration of Carbonate Ores

By Joseph T. Terry, Jr.

As a pioneer in, and a contributor to, the successful concentration of carbonate ores by the flotation process these notes may be of interest to the mining and metallurgical fraternity.

My friend O. C. Ralston of the Utah State University has written lucidly on this subject and therefore there is no need to reiterate the information disclosed in his excellent article, which was given publicity in a recent issue of the MINING AND SCIENTIFIC PRESS, but rather enlarge upon it.

Sulphide filming of copper and lead carbonates is commercially accomplished by the use of soluble sulphides, such as the sulphides of soda, or calcium and hydrogen sulphide gas. The sulph-hydrates of soda, calcium, and ammonium are exceedingly effective in causing true sulphide filming of the carbonates, but unless used in very small amount or removed by washing the pulp, seriously interfere or prevent the flotation of the filmed mineral.

Hydrogen-sulphide gas is the most satisfactory reagent and can be cheaply produced without the use of acids by the destructive distillation of numerous organic substances mixed with sulphur. This method of production offers a cheap and effective reagent for precipitating copper from acid-leaching solutions.

Sulphide filming of the carbonate minerals is best accomplished by introducing the gas into the ore-pulp crushed to -80 mesh, with a density of about 20% solid, kept in motion or agitation in an enclosed agitator, or other suitable apparatus, and subsequently subjecting to flotation under the same conditions as a natural sulphide-pulp.

In attempting the flotation of ores containing both natural sulphides and sulphide-filmed carbonates, failure to float the natural sulphides is due to what may be termed the 'wetting' action of the soluble sulphide reagents on the natural sulphides. I discovered that this can be readily avoided or overcome so that both sulphide-filmed carbonates and natural sulphides are floated simultaneously.

The sulphide film on lead carbonate is exceedingly firm and may be accomplished by introducing the sulphide-filming reagent into a ball-mill in which the ore is ground.

The film on copper carbonate is not firm and readily scoured, hence the necessity of sulphide-filming after the ore has been reduced to a pulp.

It is therefore evident that the pneumatic or Callow cell is the more satisfactory in which to accomplish the flotation of copper carbonate. When the impeller type of cell, such as the Minerals Separation apparatus, is used in concentrating copper carbonate, successive film-

ing treatments becomes necessary to secure a high recovery, except in the case of slime, but my experiments indicate that the grade of concentrate produced is considerably higher than from the pneumatic apparatus.

In concentrating sulphide-filmed lead carbonate the impeller type of flotation-cell yields excellent results, and the scouring action is less apparent. When copper carbonate ore is reduced to a colloidal slime before sulphide-filming and flotation in the impeller type of cell, the scouring action due to the violent agitation is not manifested, and a high-grade concentrate with excellent recovery is possible without repeated sulphide-filming treatments. I am not prepared to state the physical and mathematical law governing this condition, but foresee an interesting problem in the realm of physics and colloidal chemistry for those qualified to solve it.

It must not be construed that all copper carbonate ores are susceptible to concentration by flotation. I have encountered several instances where the mineral was so intimately associated or combined with the gangue that neither a satisfactory recovery nor a good grade of concentrate was attainable. However, there is a vast tonnage of copper carbonate ores in the Western states that is amenable to the sulphide-filming flotation process.

Copper and lead carbonates in combination with iron oxide do not yield a high-grade concentrate, as much of the iron oxide is filmed and floated.

It is a noteworthy fact that oxide of tin (cassiterite) is particularly susceptible to sulphide-filming and flotation, yielding both a clean concentrate and a high recovery. This is due to the crystalline nature of the mineral.

GASOLINE extracted from natural gas during 1915 amounted to 65,364,665 gal., valued at \$5,150,823. There were 414 plants operated, California having 20, Illinois 16, Ohio 50, Oklahoma 63, Pennsylvania 139, and West Virginia 114. The average recovery of 'gas' per 1000 cu. ft. of natural gas was 2.57 gal. The 1915 output was a gain of 53%. There was also an increase of 7% in the number of plants.

NATURAL gas production of the United States in 1915 amounted to 628,578,842,000 cu. ft., sold for 16.12c. per ft. Domestic consumers paid 28.32c., and industrial concerns 9.7c. per 1000 cu. ft. The output is 6% greater than in 1914. West Virginia produced 244,004,159,000 ft., Pennsylvania 113,691,690,000 ft., Oklahoma 87,516,753,000 ft., and California 21,891,035,000 feet.

THE MT. BOPPY MINE, the largest gold producer in New South Wales, Australia, treated 6336 tons of ore in August, yielding \$40,000.

Mining Method at Inspiration

By George R. Lehman

*The Inspiration company's method of mining is one of the so-called caving-systems, whereby the ore is caused to cave and crush itself thus reducing to a minimum the blasting and handling. It is a modification of the method introduced by Felix McDonald at the Ohio Copper Co.'s mines in Utah, and was put into operation at the Inspiration under his supervision. The method consists, essentially, of under-cutting the ore (taking out a horizontal slice), allowing the ore above to cave and crush, and drawing off the crushed material through small inclined raises driven under the caved ore, into main inclined raises that lead down to the haulage-drift chutes.

PRELIMINARY WORK. By referring to the accompanying illustration a good understanding of the method will be obtained.

After shafts have been sunk, the haulage-drifts are driven under the ore of the section or sections to be mined at intervals of 100 ft. as shown in Fig. 1. These drifts are of large size, being 9 ft. wide at the base of the rails, $7\frac{1}{2}$ ft. wide at the cap, and $7\frac{1}{2}$ ft. high above the rail-base. Where timbered, the above refer to inside-timber dimensions.

After the haulage-drifts are completed, or during their driving, 'pony' sets are erected every 25 ft. along the drifts. The pony set is about 5 ft. high, placed on top of the regular drift-set and is the place from which the car-loaders operate the chute gates discharging into the haulage-cars.

Inclined raises are then started from the pony sets at an inclination of from 50 to 54°, depending on whether the sub-levels are to be 30 or 35 ft. vertically apart, in a plane at right angles to the haulage-drifts. When these raises are up from 10 to 15 ft., chutes are built at the pony sets and ore-gates of steel are installed.

The raises are then advanced until the first sub-level is reached. Sub-drifts are then started from the first raises to reach the required level, and are driven parallel with the haulage-drifts. These drifts break into the other raises every 25 ft. as they advance. The raises are again advanced to the next sub-level where drifting is to start. The drifts as they advance connect with the raises. All of these development-raises are about 4 ft. diam., and the sub-drifts 6 by 7 feet.

This method of raising and sub-level drifting is continued until the height is reached where the first under-cut is to be made, and the drifts are driven as before to connect with the raises.

The first under-cut sub-level will be started below the top of the ore, at the height at which it is intended to cave. When the preliminary development is finished, the sub-level drifts on the first under-cutting level are 50 ft. apart, as they are on the 'sub' just below, as shown in Fig. 1. On all the 'subs' below, the drifts are 100 ft. apart. All the drifts on each 'sub' are also connected with inclined raises every 25 ft. Cross-drifts, connecting all the drifts on each 'sub,' are also driven at intervals of about 150 feet.

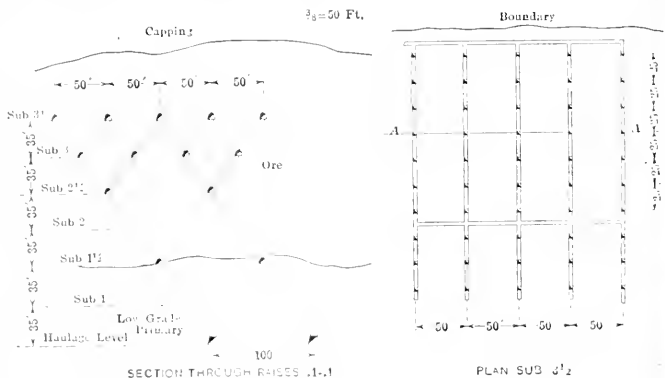


FIG. 1. PRELIMINARY DEVELOPMENT DRIVING INCLINED RAISES FROM HAULAGE-LEVEL DRIFTS.

The next work, before under-cutting is commenced, is to drive on the level to be undercut other sub-drifts, between and parallel with those already driven, making the drifts on this 'sub' 25 ft. centre to centre. These drifts, as they advance, meet branch raises of the main inclined raises at $12\frac{1}{2}$ or 25-ft. intervals as desired. These small branch raises are called 'finger raises,' many of which are put up just before or ahead of the undercutting operations.

UNDERCUTTING the ore is accomplished by starting at a cross drift, on the boundary of the section to be mined, and in retreating from that cross-drift, drilling deep holes, nearly at right angles to the drifts, into the pillars between them, and blasting out the ground. Three holes are drilled in each side at different angles in the same vertical plane, with one hole in the back of the drifts, thus making seven holes to the ground. For this work a water hammer one man drill with large steel is used. The holes are from 8 to 10 ft. deep. Usually the

*Excerpt from paper presented at Arizona meeting of American Institute of Mining Engineers (September 1916).

rounds are blasted one at a time, the under-cutting receding from the caved ground.

Ore from the under-cut is drawn through the finger raises, in each of which has been built an ordinary board chute to control the drawing. The finger-raise chutes are placed about 4 or 5 ft. below the sub-level so that they will not be blasted in shooting the under-cutting holes.

While in some ground, the ore begins to cave as soon as under-cut, in hard ground it does not start until the under-cutting has receded a considerable distance.

ORE DRAWING. After the ore caves it is drawn as desired. Large boulders that will not pass the raise-chutes are blasted. In drawing the ore, the 'chute-tappers' work in pairs. One 'tapper' goes up a raise, from the 'grizzly sub,' which is the first 'sub' below the under-cutting level, opens a chute-gate and draws the

For hoisting ore, two main shafts 101 ft. apart are used. Both shafts have three compartments, of which two in each shaft are skip-ways. The third compartment in one shaft contains the ladderway, pipes, and electric conduits, while in the other shaft the third compartment contains an Otis double-deck elevator for hoisting and lowering men. The shafts, underground bins, and stations are all lined with reinforced concrete.

Only two levels are used for hauling ore, the 4th and 6th. The vertical distance between levels is 130 ft. An idea of the arrangement of the mine is obtained from Fig. 2. On the 6th level the shafts are connected by two drifts, one for each shaft. In each drift there is a tippie over the bin at the shaft. The arrangement of the drifts, bins, tippies, and stations is symmetrical with a centre line between the two shafts so that the tippies are operated by one man from a central point.

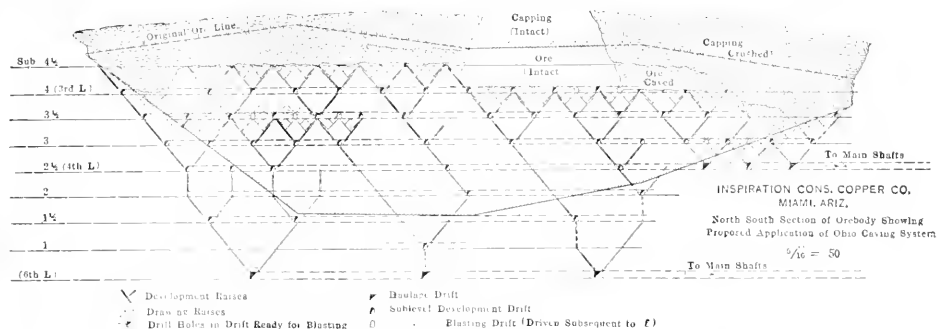


FIG. 2. ARRANGEMENT OF MINE LEVELS AND RAISES UTILIZED IN INSPIRATION CAVING SYSTEM.

ore, while the other tapper works the ore through the grizzly on the 'sub' below.

All grizzlies have about 1-ft. openings and are made of timber or steel rails. They are placed over all raises on the 'grizzly sub' and are set at right angles to the drift. Pieces of ore too large to pass are broken with an 8-lb. hammer by the tapper tending the grizzly.

After passing the grizzlies, the ore falls into the main raises and down to the haulage-drift chutes where it is loaded into 5-ton cars and hauled in trains, of 15 to 20 cars, to the shaft-bins.

The second under-cut can be started at one, or any number of sub-levels below the first under-cut, according to the height of ore that it is desired to cave. It could begin at the bottom of the ore if desired. In fact, the first under-cut could start at the bottom of the ore if it were known that the orebody to be mined could be caved throughout its total height.

HAULAGE AND HOISTING. At the Inspiration mine the ore-trains are hauled by compressed-air locomotives. Arrived at the shaft the cars are emptied into the shaft-bins by barrel-shaped tippies, five cars at a time. From the shaft-bins the ore is loaded automatically into 12½-ton skips and hoisted by electrically-driven automatic hoists to the steel bins on the surface.

On the 4th level one double-track drift passes between the two shafts and is connected to the shaft-stations by a small cross-drift. The ore is emptied by one tippie, on this level, into a small bin, which is connected with the 6th-level bins by a concrete-lined inclined raise. This arrangement makes necessary only one loading-level for the skips.

The Inspiration Consolidated Copper Co. commenced underground development on a large scale toward the latter part of 1913 but did not start regular mining operations until August 1915. The tonnage mined gradually increased as the concentrator was able to handle it until at present (June 1916) an average tonnage of 16,700 tons is being mined daily.

The cost of mining is now 60c. per ton, including 20c. for development and all fixed charges.

The percentage of ore and copper extraction obtained by this method cannot be determined positively until some section has been entirely mined from top to bottom of the ore. Based on results in six sections of the mine from the first under-cut to the capping estimated to contain 1,886,450 tons, and which has been almost completely drawn to capping, the ore extraction is 102.44% and the recovery of copper 86.52%. The second under-cut is expected to increase the copper recovery.

The Institute Meeting

By Charles F. Willis

For the first time in 15 years the American Institute of Mining Engineers has honored Arizona by conducting its annual meeting within its borders. It was a belated recognition of the growing importance of Arizona as a mining region. The New York delegation numbered 35, others joining the party at Albany and points in the Middle West. At Chicago they were entertained by the local section, many of whom joined the party. Attached to the train was the private car of Ben. B. Thayer, past-president of the Institute.

On the way to El Paso the engineers were given an opportunity to study the geological conditions and mineral resources of the country through which they were passing and its environs by the use of a geological map presented individually to the members by Carl Scholz. At Kansas City, the party was joined by the Missouri delegation, which included Philip N. Moore, presidential candidate, and D. A. Buchler, State Geologist of Missouri.

El Paso was reached the next afternoon. The visitors found a fleet of automobiles awaiting them for a passing inspection of the many local points of interest. They visited first the mobilization camps of some 90,000 troops stationed outside the city, and the border patrol. Some of the party went to Juarez, Mexico, where a bullfight was witnessed. Toward the end of the day the party was taken through the great smelter of the American Smelting & Refining Co., Karl Eiders conducting them and explaining the metallurgical methods. Keen interest was shown in the basic converter and the casting system in use at this plant. At 7 o'clock a Mexican dinner was offered by the El Paso members of the Institute, during which a Mexican orchestra provided music. Following the dinner, L. D. Ricketts proposed a rising vote of thanks to the hosts, this being acknowledged graciously by Mr. William W. Rose. The party entrained at 11 o'clock for Santa Rita and Hurley.

It is reported that three engines and all the 'dinkies' in the State were necessary to push the heavy train to the Santa Rita mines. The result was duly accomplished, and when the Chino Copper Co.'s men had sufficiently recovered from their astonishment at the appearance of the long steel snake, an explosive serenade nearly convinced the delegates that Villa had preceded them. The early morning was spent in inspecting the big open cuts, the interest of the engineers being especially caught by the crushers and steam shovel methods. Following this visit automobiles carried the party to the mills of the Empire Zinc company, which demonstrated new magnetic processes that many of the visitors had not seen before. A ten-mile automobile run through a part of the valley now opened by prospectors com-

pleted the morning program. Returning to Santa Rita the engineers found a barbecue awaiting them.

Upon arrival at Hurley, the visitors, in small groups, spent two hours in a study of the methods of the Chino mill. To many members this was the first introduction to the flotation process, the magnetic separator, and the Garfield tables. All Hurley was ready for the delegates, and refreshments and entertainments were provided until 11 o'clock, when the train left for Douglas. It was generally agreed that the day in New Mexico had been a revelation of Western hospitality.

At Douglas, under the guidance of Messrs. G. H. Dowell, A. V. Dye, Forest Rutherford, and a corps of assistants composed of the heads of departments, the visitors were shown over the big smelter of the Copper Queen Consolidated. As they started on their tour they were given booklets describing the plant in detail. From the power-house, through the converter-building, to the reverberatory-building, the roasters and the storing-yard, where thousands of dollars' worth of copper in bars is stacked, the excursion was led.

Promptly at 10:45 the delegates boarded the train for the Calumet & Arizona smelter, where another tour awaited them. Through the mill and sampling plant, with their wonderful conveyor-belt system, to the ore-beds, where charges are automatically mixed, then to the acid plant, which will have an ultimate capacity of 200 tons of sulphuric acid daily, the crowd streamed. Here they watched the lead-burners lining one of the mammoth tanks with sheet-lead, while above them the structural-steel men were riveting and higher still a force was building the roof. Then the main smelter-building, with its reverberatory furnaces, blast-furnaces, converters, and finally the molding department, were visited.

Luncheon was served near the main building. To say that it was enjoyed is putting mildly the feelings of those who had taken the long walks necessitated by a full view of the plants. The artillery band played a concert for an hour, when the excursionists took the train to Douglas to attend the first serious session. This was held in the Y. M. C. A. building, which had been decorated for the occasion. Dr. Ricketts, president of the Institute, announced that he would temporarily relinquish the chair to Walter Douglas, who acted as chairman.

The chair called on John C. Greenway, general manager for the Calumet & Arizona Mining Co. to make the address of welcome. This Capt. Greenway did in a graceful manner in behalf of the local chapter of the Institute and the people of the State. After devoting a short time to the pleasant task of making them welcome,

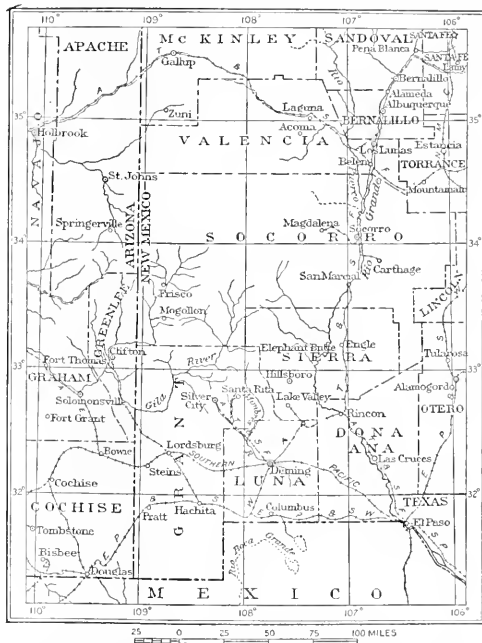
the speaker told the members of the Institute in some detail the program for the remainder of the week. Mr. Douglas called on Dr. Ricketts to respond, but the latter saying that he was a host like the rest of the Arizonians, asked Mr. Thayer, of New York, to reply. In doing this, Mr. Thayer paid a beautiful tribute to James Douglas, who, he said, had done more for copper mining than any other individual. He also offered the suggestion that the people of Arizona should honor the man whose handiwork is to be seen in practically every smelter or concentration plant in the State by naming a lively town after L. D. Ricketts. This suggestion was received with much applause.

The schedule of arrangements for the remainder of the trip was then read by the Secretary, Bradley Stoughton. Mr. Douglas requested that after each paper on the afternoon program had been read, the interesting points brought out should be discussed for five-minute periods by as many of the delegates as felt inclined to do so.

A. C. McGregor, designer of the C. & A. plant and the Arizona Copper Co.'s plant at Clifton, read an interesting treatise on 'Features of the New Copper Smelting Plants in Arizona.' Dr. Ricketts led the discussion, saying that the advance in smelting lies in the prevention of loss. He then discussed the loss of 0.7% copper at the International smelter at Miami. E. P. Mathewson, superintendent of the Anaconda smelter, commended the local smelters for their cleanliness of operation and congratulated the designers of Arizona plants. A paper by F. N. Flynn, superintendent of the Arizona Copper Co.'s smelter, was then read. The absence of L. O. Howard necessitated the reading of his paper, 'The Basic-Lined Converter in the Southwest,' by the Secretary, Mr. Stoughton. This precipitated a great discussion. Mr. Douglas told of one converter-lining in the Old Dominion smelter that had produced more than 70,000,000 pounds of copper before it had to be replaced. Mr. Mathewson discussed the comparative merits of the Smith-Pierce and Great Falls types of converters at some length. Kuno Doerr, general manager for the A. S. & R. at El Paso, made a brief talk along the same lines.

'Determination of Dust-Losses at the Copper Queen Reduction Works' was the title of a paper read by J. Moore Samuel. Dealing as it did with the recovery of metal that formerly had passed out of the stack as smoke, the paper brought about a discussion of a vital subject. Mr. Douglas discussed it briefly, being followed by Mr. Mathewson, who said that the methods employed by the Anaconda smelter to abstract the value from fume were somewhat similar to those of the Copper Queen, and compared such extraction with methods of treating flotation-concentrate. The recovery from fume at Anaconda had materially reduced the damage done to farms in the surrounding district, he said, and the company had been upheld in this contention by the courts, which had found that the resultant loss to farmers was negligible. He then called attention to the importance of choosing a good site for a smelting plant, as

a poor one would result in almost certain damage to the surrounding country, while a good site would save much unpleasantness. Sidney J. Jennings, Vice-President of the Institute, discussed the same topic and suggested that considerable loss is made at the smelting plants in the South-west by reason of the high winds, which carry the dust away. Mr. McGregor said that the C. & A. probably suffered loss from its ore-beds owing to the high winds, and with that fact in view, the ore-beds had been housed. Mr. Douglas pointed out the fact that at



SOUTH-WESTERN NEW MEXICO AND PART OF ARIZONA, WHERE THE
ENGINEERS VISITED.

the local smelters ores averaging 6% are treated, while the Miami concentrate averages from 30 to 40%. Dr. Ricketts agreed that in all smelters means should be taken to prevent ore dropping through the air. It should all be hoisted, and a hose could be used to wet it, so as to prevent dust. The men need not go in the houses while the ore-beds were being filled. He expressed the belief that such precautionary measures would pay. He also discussed the Cottrell system, which he had found to reduce the loss in fume to almost nothing.

Following the adjournment of the afternoon session, many of the delegates took motor-cars over the district, visiting the camps of the regulars and militia-men in this vicinity, also crossing to Agua Prieta.

The night session opened with a large crowd in attendance, many mining men not on the excursion taking this opportunity to hear the papers and discussions. H. W. Morse was the presiding officer. The first paper read was that of the chairman and H. A. Tobelman, on leaching tests at New Cornelia. Mr. Morse read the

paper and then with the aid of stereopticon views, showed several of the methods of leaching that had been tested at Cornelia and found successful. For a time he was bombarded with questions from all sides. 'The 2000-ton Leaching Plant at Anaconda' was the title of a paper by Frederick Laist and H. W. Aldrich; this was read by Mr. Mathewson, and discussed in some detail by him. F. N. Flynn and others asked a number of questions regarding technical points. Secretary Stoughton read the treatise on 'Possibilities in the Wet Treatment of Copper Concentrates,' prepared by Lawrence Addicks of New York. Mr. Morse and several others discussed this phase of leaching. A. G. McGregor, in an address on the 'New Copper Smelting Plants in Arizona,' told the engineers that in Arizona during the past five years there had been more activity in copper-smelting plant-construction than in the same length of time in the history of the world. Mr. McGregor said that in this period five new smelting plants had been constructed and put into operation; the monthly output from these plants averaged from 5,000,000 to 18,000,000 pounds. He then described new problems that had been solved successfully, and new features in plant design and equipment that had been developed. Following adjournment, many of the delegates went to the Country Club to attend a reception and dance given in their honor; this was largely attended by Army people and residents of the district.

At Bisbee the following day the visitors were met by a brass-band and 50 automobiles, which carried them around the district. Many went underground through the mines, while others remained on the surface. The Bisbee sessions were full of good things.

The State of Missouri and not the eastern coast-line should be the site of the proposed Government munitions plant, according to H. A. Buehler, State Geologist of Missouri, who spoke at the Bisbee session. Mr. Buehler supported his contention by a summary of the mineral resources of Missouri.

A further handicapping of the chemical industries and the paint and dye manufacturing interests of the country, due to a lack of manganese ores, was predicted in a paper by E. C. Harder of the U. S. Geological Survey. Mr. Harder explained that even at the beginning of the European war there had been a great decrease in imports of both ores and alloys of manganese, and that since 1914 the price had risen from \$37 to \$100 per ton, with ferro-manganese still higher. He said: "The situation in the United States at the present time regarding the supply of manganese ores and alloys of manganese is one of great seriousness and is likely to become increasingly so while the War continues. The dependence of the country upon foreign countries for this supply is being forcibly indicated."

Other papers attracting attention were 'The Geology of the Warren Mining District,' by Y. S. Bonillas, J. B. Tenney, and Leon Feuchere; 'Co-operative Effort in Mining,' by Joseph P. Hodgson; and 'Gold and Silver Deposits in North and South America,' by Waldemar

Lindgren. In this paper Dr. Lindgren stated that the South American mineral resources in precious metals are less than those of our continent and that even progress and enterprise will be unable to raise its production to approach the figures attained by North America.

At the close of this session the visitors were banqueted at the Country Club, after which they proceeded to Globe, arriving on Thursday morning, the 21st. During the morning the party visited the mines and reduction works of the Old Dominion Copper Mining & Smelting Co., and were greatly impressed. The afternoon and evening were reserved for the discussions of subjects relative to mining in the Globe district. It was at these meetings that the engineers discussed the means for developing the flotation process.

Chief among these conclusions was the prediction that the flotation process is now in its infancy and that with the discovery of new flotative agents further development is assured. The afternoon meeting was marked by the first public presentation of a report of experiments on several miscellaneous wood-oils. A statement concerning these oils was presented in a paper by Glenn L. Allen, of the Shattuck Arizona Copper Co., and O. C. Ralston, of the U. S. Bureau of Mines.

Rudolf Gahl, of the Inspiration Consolidated Copper Co., rendered the afternoon meeting memorable by his account of the history of the flotation process at Inspiration. Dr. Gahl told of the exhaustive research and experiment of his company in an effort to develop the flotation process, and pointed out that the vast expenditures demanded for this experimentation had been made to pay for themselves by the results achieved.

Mining and smelting constituted the general subject of the evening session. This evoked an interesting discussion on the methods of fighting mine-fires, with especial reference to the plenum system. At the close of the evening an illustrated description of the Cottrell process was given by G. A. Schmidt.

Globe saw the ending of the full meeting. While the greater number went by automobile the following day across the Apache trail and by the Roosevelt dam, others went directly to their homes and offices. The trip over the historic Apache trail was both pleasant and instructive. Excellent opportunity was offered for geological observation, while those whose interests were chiefly mechanical, found much of interest in the Roosevelt dam and the power-houses which furnish the power for Globe and Miami. At Phoenix more of the party left, bound particularly for properties in which they were interested, and which were out of the line of travel. A number left for a side trip to the Ray Consolidated Copper Co., at Ray and the mill and smelter at Winkelman.

METAL EXPORTS from the Malay States, south-eastern Asia, during the first half of 1916 were as follows: gold, 8074 oz.; tin, 260,000 tons; and wolfram, 186 tons.

RAILROAD MATERIAL EXPORTS in the year ended June 30 totaled \$74,729,000, over double those in the previous period.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

JOPLIN, MISSOURI

REDUCTION IN SURPLUS ORE AND PRICE OF POWDER.

Renewed activity in the ore-market has resulted in the disposal of a large part of the surplus concentrates which have acted as a depressing factor during fully six months. There is more optimism felt than for weeks. The previous week started the ball rolling, and the momentum gained by the first of this week was such that a heavy tonnage of low and medium-grade zinc-blende was purchased, the price ranging from \$5 to \$10 per ton above the levels that have prevailed for three months. This buying movement coming at the same time as the attempt of ore producers to curtail the output voluntarily, and the probability of a coal strike which would force the closing down of many mines for lack of power, has created a much better feeling, and has brought hope that the disturbing element of concentrate stocks might be wiped out before the beginning of winter. There is a possibility of reduction in the cost of dynamite. For some mines the cost of powder has been prohibitive, and as old contracts expired, forcing these companies to buy in the open market. Properties in the sheet-ground and low-grade disseminated district thus have been forced to suspend operations. Sixty days ago a large number of these old contracts expired, and that time marked the cessation of activities of a considerable number of the heaviest consumers of dynamite in the region. The powder companies have reduced the cost of powder \$2 per 100 lb., and also lowered the price of caps slightly. While this reduction averted the closing of some of the mines, it was not a sufficient cut to make any material difference to the majority. An announcement this week in a semi-official way, by N. P. Rood of the Hercules Powder Co., states that there would be another reduction in the price of powder, one of the largest factors in the cost of mining, probably before the first of the new year. The decreased price of powder, with the lower price being received for zinc-blende, brings back into the production list a large number of sheet-ground producers who have been forced to close. This change in the price of powder would give relief to the distressful labor conditions, as so many mines are closed resulting in many miners being out of employment or working half-time. Some of the miners have left the field, and in this way relieved the situation to a limited extent.

MEXICO CITY, MEXICO

NEW DECREE AFFECTING MINING OPERATIONS.

After the usual preamble that occupied more space than the decree itself, the following appeared in a Carranzista newspaper published at San Luis, San Luis Potosi, about September 14:

ARTICLE 1. All grantees of mining concessions must work there-upon, under penalty of their forfeiture if such work be suspended for more than two months continuously, or for more than three months interruptedly, during each year.

ARTICLE 2. Any grantee having a good excuse for not working may solicit of the Secretary of Fomento the corresponding permission. This can be granted only in case the reasons submitted be well founded and proven, and for a period not to exceed three months, unless at the expiration of this period there still exists a cause rendering absolutely impossible any operation; in which event, such further time as may be deemed strictly necessary can be given.

ARTICLE 3. The Secretary of Fomento, duly considering the cases presented by the owners of mining concessions, shall designate for each of the new concessions, as well as for each of the old ones not yet exploited, the number of laborers which, as a minimum, must be employed thereon, taking into account the number of claims of each concession.

ARTICLE 4. The mine-owners who may have had, or may have, their properties under exploitation, must employ the same number of men that have been or were employed at the time operations were suspended, the Secretary of Fomento reserving the right, in view of the allegations submitted by the mine-owners, to change this number according to the necessities of the case.

ARTICLE 5. Whenever the Secretary of Fomento declares forfeited any mining concession, he shall immediately bring



said declaration to the notice of the Secretary of Hacienda, in order that the latter decide whether the annulled concession shall thence-forward be open to public denouncement, or be worked and operated under the auspices of the Nation, in which latter event, he shall appoint a person for its management in the continuation of the corresponding work.

ARTICLE 6. This law shall take effect from the date of its publication.

National Palace, Mexico, September 14, 1916.

(Signed) V. Carranza.

SUTTER CREEK, CALIFORNIA

STRIKE SITUATION.—OLD EUREKA, HARDENBERG, and ROSE MINES.

The following notes were written on October 1:

The strike situation remains apparently unchanged. Ben Goggin, general organizer of the Western Federation of Miners, has issued a statement to the effect that the Union is not demanding recognition of its organization, and states that the men are willing to return to work when they receive an increase of 25c. per day, with the assurance that Union men will not be discriminated against, because of their membership or participation in the strike. Nothing is being said about the reported demand for shorter hours, or to have the employee's time begin and end at the collar of the shaft, instead of at the working face in the mines. The Union claims that the mine-owners have never been asked to recognize the organization, and that if the 25c. increase be allowed on the above

understanding, an agreement will be signed by which members will refrain from making further demands for a period of two or three years, or such further time as may be agreed on. Business-men in this region are feeling the effects of the strike, and it is estimated that since the men went out on September 19, they have lost over \$40,000 in wages. The mines and plants remain uninjured, with the exception that pumping expense and repair work is kept up without the revenue from gold won. The owners claim that their properties are well prepared for this situation, and that by means of proper attention to underground conditions the mines will be in as good condition six months from now for the resumption of work as they are today. They claim that 1200 of the 1500 miners of Amador county are quite willing to return to work on the old basis, but apparently the owners wish to avoid disturbances and annoyances likely to result if the strikers are replaced with other men, so no move has yet been made toward that end. The only mill at work in the county is that of the Plymouth Consolidated.

The Old Eureka shaft has been unwatered to a depth of 700 ft., and thoroughly repaired from the surface to that point. Tracks are now being laid from the new modern saw-mill to the collar of the shaft for the convenient handling of supplies. Grading for the new steel hoist is progressing well, although the present low wooden structure will doubtless remain in use for some time. A new double-drum hoist has been ordered.

The machinery at the Hardenberg mine on the Mokelumne

ing has occurred so far. In the south end of the district all of the mines are closed, except the Amador Consolidated, (Old Eureka), although a few men are employed on repairs at practically every mine. I am informed that a few hundred men, probably as many as 400, have left the district since the strike was called. This will certainly have the effect of leaving the mines short-handed when they are ready to resume. It is claimed by the Western Federation officers that none of the Union men have left the district, but well-informed people claim that this is not true. They say that a large number of Union as well as non-union men have taken their departure. So far there have been few acts of violence, and the offenders have been taken in hand by the Sheriff, who shows strong determination to do his duty without fear or favor. He has appointed a number of extra deputies, including some from the ranks of the Union and expresses himself as determined to prevent violation of the law, whether by miners or mine operators. Naturally there is in this respect, a feeling of confidence that there will be no serious violence.

TORONTO, ONTARIO

SUMMARY OF MINERAL OUTPUT FOR HALF-YEAR.

Returns of production for the first six months of 1916, made to the Ontario Bureau of Mines by the metalliferous mines and works of the Province, are summarized in the following table, which also gives comparative quantities and values for the corresponding period of 1915:

Product	Quantity		Value	
	1915	1916	1915	1916
Gold, ounces	173,021	235,060	\$3,570,972	\$4,822,740
Silver, ounces	11,101,909	10,267,743	5,188,763	6,188,269
Copper, pounds		77,795		14,368
Cobalt (metallic), pounds		121,817		103,677
Nickel (metallic), pounds		13,933		5,899
Molybdenite (concentrates), pounds		12,631		13,975
Cobalt and nickel oxides, pounds	141,500	401,408	56,812	204,638
Copper in matte, tons	8,523	11,426	1,704,600	2,285,096
Nickel in matte, tons	15,182	20,651	7,591,000	10,325,766
Iron ore, tons	134,977	80,698	288,296	243,268
Pig-iron, tons	225,940	295,349	2,856,040	4,424,496

river, 31 miles south of Jackson, was re-started during the week. A new cable is now being installed, and the work of unwatering and repairing the shaft at this old producer will soon be under way. The property has been taken over by the W. J. Loring Co. The men interested in the Hardenberg mine are Americans, and the present deal is said to include other valuable mining ground in that vicinity. The Hardenberg is equipped with a 20-stamp mill, electrically-driven hoist, and a well-timbered, double-compartment shaft.

San Francisco people have been here inspecting the Rose mine, which is about a mile east of Sutter Creek. This property is owned by L. R. Poundstone of Colusa county, and has been worked irregularly during the past 40 years. Recently the mine was equipped with a 20-stamp mill, compressor, small hoist, and has been opened by two shafts, which the owner has kept unwatered since the cessation of operations some months ago.

AMADOR CITY, CALIFORNIA

THE STRIKE SITUATION FROM ANOTHER CORRESPONDENT.

There is no change in the strike situation, except that the Keystone mill, which was running a week ago, is now closed down. It is understood, however, that this is in accordance with a pre-determined plan which contemplates closing the mine for about 60 days for the purpose of re-timbering 300 ft. of the shaft. At Plymouth all is quiet and a full complement employed. There are rumors of possible attempts from the outside at interference with operations at Plymouth, but nothing

Production for the period ended June 30, 1916, shows a material increase in value of all metals over that for the first six months of 1915, with the single exception of iron ore.

GOLD. If the present rate of production is maintained, Ontario should reach the \$10,000,000 mark for 1916, compared with \$8,500,000 in 1915. Of the total yield, Porcupine contributed all, with the exception of \$545,434 produced by the Croesus in Munro township, the Roggon near Dryden, the Tough-Oaks at Kirkland Lake, and the Canadian Exploration Co. at Long Lake near Sudbury. The Hollinger Consolidated and Dome Mines are the largest producers at Porcupine. Before the year ends Boston Creek will probably be contributing to Ontario's gold yield. Development is proceeding on some of the more promising claims at Kowkash (situated east of Lake Nipigon) on the National Transcontinental railway.

SILVER. Since the beginning of 1916 the price of silver has advanced considerably, the average being 62½¢ per ounce—low 56½ and high 77½¢. As a result production has been stimulated, and the value, compared with 1915, shows a considerable increase. Although the quantity sold was less than for the corresponding six months of last year, the total output was greater, over 1,000,000 oz. remaining to be marketed. Undoubtedly the life of Cobalt will be prolonged as a result of introducing flotation treatment for low-grade dumps and slime. The Nipissing still leads in output with a value of \$1,766,561. The Mining Corporation of Canada—Cobalt Lake and Townsite City—is the next largest producer, followed by Kerr Lake, Coniagas, and McKinley-Barragh-Savage.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

CORVOA. For the sum of \$30,000 the Kennecott Copper Corporation has purchased the Wilson-Littles property on Latouche island. A considerable amount of development has been done, and the mine is well equipped.

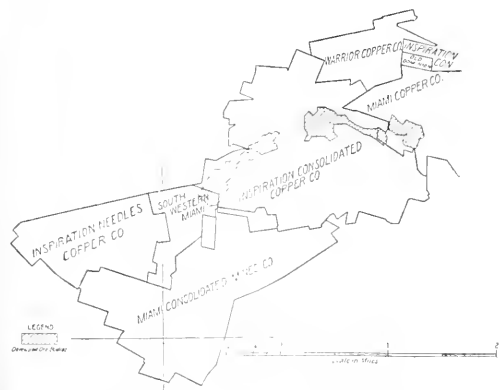
VALDEZ. A preliminary report has been made by Pierre Bonery, manager of the Valdez Creek Placer Mines. A few days' sluicing in an old channel yielded gold worth \$20,000. As the power-plant was threatened by water it was removed. This gives plenty of dumping ground. The ditch has now a capacity of 3500 miner's inches of water. The face of the present gravel pit yields high by panning.

ARIZONA

CHLORIDE. The population of this centre is now 1200, and is increasing steadily.

GLOBE. With a capital of \$5,000,000, the Greater Ajo Copper Co. has been organized by Globe men. The property to be developed is in Yuma county, 100 miles from the Mexican border. A. B. Saling and others of Miami located 100 claims last April. The new centre is called Copperton. A. Reid is secretary and L. M. Greenstein engineer. It is said that the deposit could be worked by steam-shovels.

MIAMI. To develop 62 claims adjoining the Inspiration, Miami, and Inspiration Needles properties, the Miami Con-



LATEST PROPERTY MAP OF MIAMI, ARIZONA.

solidated Mines Co. has been organized with a capital of \$2,500,000. John S. Cook and others are behind the project. Two drilling experts have been engaged to prospect the ground.

CALIFORNIA

Oil production of the State in August totaled 294,457 bbl. daily, an increase of 1000 bbl. over July. Shipments from the fields amounted to 9,458,850 bbl., the largest for any month. Stocks declined 1,415,669 bbl. to 49,718,180 bbl. In the 10 fields there were 74 new rigs, 250 wells drilling, 51 wells completed, 2 wells abandoned, and 7071 wells producing. Crude-oil prices at the well, 14 to 18° gravity, were 63c. per bbl., and for 25 to 26°, 72c. per barrel.

ALLEGHANY. Development at the Plumbago gold mine is reported to be encouraging, keeping the mill working steadily. —Ten stamps at the Tightner are crushing ore from the mine, and five are crushing dump material.—The Rainbow Extension has been bonded.

CERRO GORDO. The Cerro Gordo Mines Co. of Inyo county has declared a dividend of 2½c. per share. When L. D. Gordon of San Francisco assumed control a year ago, and during three months of a lease he had previously obtained, just prior to operations on company account, he directed extraction of all available zinc ore. Since that time the company has paid-off an indebtedness of \$40,000, created a treasury reserve of \$50,000, paid its \$25,000 on the outstanding 1,000,000 shares, and paid for improvements costing \$15,000. The latter included a complete electric system to operate hoist and compressor, a warehouse at Keeler, and the covering of three tramway terminals. The gross revenue represented in these items is about \$120,000. The production of zinc and silver continues at the usual rate, and the management believes that the dividend rate may easily be maintained. Daily shipments are 50 tons by way of Mina and 40 tons through Owenyo. Last week high-grade lead ore was cut on the 400-ft. level, this shoot being the one opened at 200 feet.

COPPERPOLIS. Near this place the American Asbestos & Mfg. Co. of San Francisco is developing a large deposit of asbestos. The mineral is said to have a long fibre.

Construction of additions to the Calaveras Copper Co.'s mill is making good progress.

GRASS VALLEY. The Prudential mine has been sold by G. W. Root to F. M. Shideler of San Francisco, F. L. Rodgers of Connecticut, and others. An old shaft is down 750 ft., and a new one is down a good depth. It is probable that the Norambigua mine will be acquired also.

HART. A controlling interest in a new company to take over the Ore Belle Mines Co. has been secured by John Hays Hammond and others of New York. Two veins are being developed from a shaft 850 ft. deep.

IDRIA. The Panoche Valley Railroad Co., recently incorporated at Los Angeles, is issuing bonds to pay for a railway 52 miles long from south Dos Palos in Merced county to the Ashurst ranch in San Benito county. This line would pass close to the New Idria quicksilver mines, which are now 40 miles from any road, in mountainous country.

JACKSON. At the Kennedy tailing-dam an additional 25 ft. is being added by the firm that recently constructed the Argonaut dam.

MISKERSVILLE. Land on Stuart's fork in Trinity county belonging to J. C. Van Matre has been bonded to C. Mitchell and J. Bauer of Alaska. Drilling is to be done on the 650 acres, followed by dredging, if the land is valuable enough.

OROVILLE. Karl Brehme and a number of Los Angeles capitalists who are interested in the construction of the Slate Creek impounding dam have made application to the California Debris Commission to hydraulic ground owned by the company near St. Louis, on the Oroville-La Porte road. The Commission will no doubt grant the permit provided the dam is built to meet certain requirements.

PLACERVILLE. The chrome deposits of Hill & Hobler at Negro hill have been sold to the Noble Electric Steel Co. of San Francisco. The ore is hauled to Folsom by truck. The daily output is to be 25 tons.

COLORADO

BRECKENRIDGE. A syndicate headed by Bulkeley Wells of Telluride, and Leadville people, has taken over the Puzzle mine, an old producer. When new machinery is installed the shaft is to be sunk. The Puzzle Leasing Co. has been developing the Gold Dust mine for two years, and will continue its interest with the new owners.

CRIPPLE CREEK. The Vindicator Consolidated hopes to be treating ore by flotation in its new plant by November. This will deal with 350 to 500 tons daily, later on to be considerably increased. The mine contains large reserves of \$5 to \$8 ore suitable for this process. On No. 16 level the orebody is said to be 50 ft. wide, averaging \$30 per ton.

Fifteen sets of lessors are extracting rich ore from the El Paso Consolidated. The company has three machine-drills on exploration work.

DENVER. At Utah Junction, near Denver, the Ferro Alloy company is erecting two furnaces to reduce tungsten concentrate from the Rare Metals company's mill at Rollinsville, near Boulder, and make ferro-tungsten for the market.

LEADVILLE. Pumping, to unwater the Carbonate Hill and Graham Park districts through the Wolfstone and Greenback shafts, was started on September 27. Layne-Bowler pumps are working in both shafts. Water-level is at 1000 ft., and pumping will continue to a depth of 1120 ft. in the Wolfstone and 1350 in the Greenback.

At the Penrose pumping shaft the sinking pumps are being transferred to a station at the bottom of the shaft. The water-columns and cables are being assembled in one compartment, leaving two for hoisting. Preliminary work underground is almost complete.

Re-timbering of the Mikado shaft is finished to a depth of nearly 900 ft. Hoist foundations are being laid.

IDAHO

BOISE. The State inspector, Robert N. Bell, is authority for the statement that the richest discovery of gold quartz in the history of the State was made recently in an abandoned mine at Atlanta, 80 miles from Boise. The new shoot, 2 to 10 in. wide, has been opened for 250 ft. The ore is at a depth of 1000 feet.

BRUNER. During the half-year ended June 30, 1916, the Hecla Mining Co. made a net profit of \$766,887. This is \$295,135 more than the profit in the whole of 1915. Smelter receipts totaled \$1,979,211. Dividends absorbed \$650,000.

MULLEN. During the quarter ended June 31, 1916, the Federal Mining Co. shipped 38,972 tons of ore, returning \$624,029 net. The profit was \$268,287, a decrease of \$28,000 compared with the previous period.

On October 5 the Caledonia company paid 30¢ per share, equal to \$78,150. This makes \$755,450 for the year and \$1,638,181 to date. Net earnings in August were \$100,000.

In the Copper King mine, near Mullan, a diamond-drill has penetrated 17 ft. of ore containing from 5 to 10% lead and some copper. Drilling is being done 1100 ft. below the outcrop, and the bore was in 150 ft. before cutting the shoot.

MISSOURI

JOPLIN. Owing to a rise of \$1 per ton for calamine last week, shipments showed a gain of 500 tons. The output of the Missouri-Kansas Oklahoma region was 6525 tons of blende, 612 tons of calamine, and 750 tons of lead, averaging \$56, \$13, and \$70 per ton, respectively. The total value was \$157,433. The output for 38 weeks—\$24,800,193—is nearly that of the whole of 1915.

LINCOLN. In the central part of this State a new district is being developed, yielding an ore high in zinc-blende and lead, also high-grade baryte. A "Mother lode" is said to have been traced for many miles. Farmers have known of the deposits for years, but they never worked them to any extent.

The Saginaw Mining & Leasing Co., after nearly two years' pumping, has drained a 750-acre tract near Saginaw. This cost a large sum of money. Between 25 and 30 years ago the area was mined successfully, and has been popular with small companies. Work is carried on at a shallow depth, around 55 feet.

The Sutton, Steele & Steele company of Denver is trying to introduce its dry system of concentration into the Joplin district.

MONTANA

BUTTE. The Anaconda company has received 400 tons of high-grade zinc ore from its Douglas mine in the Pine Creek district of Idaho. This is to be concentrated, the product to be treated at Great Falls.—On the 800-ft. level of its Emma mine at Butte the Anaconda has cut 15 ft. of zinc ore. Regular shipments are made to the Washoe works.

Owing to shaft troubles the Butte & Superior August return was only 31,733 tons of ore yielding 7502 tons of zinc concentrate.

At the Butte-Duluth it is expected that the mill will be in operation within two weeks, treating 100 tons daily, in charge of George Desher. Leaching with sulphuric acid will be the first process tried. Acid is difficult to secure at present.

(Special Correspondence).—The Rothfuss-Dickmann company has received its transformer and is ready for power. The 10-stamp mill will be crushing in a short time. The owners have a large body of ore blocked-out in the Montana and Dalcourt mines, and a good quantity is on the dump for treatment.

It is reported that the old Elkhorn mine and the three large dumps of tailing, 250,000 tons, worth from \$2.50 to \$5, have been sold to the Walker interests of Salt Lake City, who will commence operation early in 1917.

The Elkhorn Bulwer mines are being overhauled. Driving proceeds at 200 ft. and ore has been struck. This mine produced \$10,000 worth of copper ore in four months from a winze 125 ft. deep, operated by a windlass. There is also a shaft 200 ft. from which a drift is being driven 60 ft. to a winze, that produced 10 to 15% copper ore. It was mined without the use of powder.

Workings of the Calumet mine have been overhauled and quarters erected for the men. This mine shows large bodies of lead and silver ore.

The Elkhorn Queen has been leased by a new party; it is an old producer of silver, lead, and gold.

The Golden Moss, a good gold and copper mine has been leased by C. R. Voreck, and development is being done. The gold ore is suitable for milling; the copper ore is of good grade. Elkhorn, September 23.

HELENA. From December 20, 1914, to August 15, 1916, the Franklin mine in the Scratch Gravel district produced ore worth \$242,517. The net profit was \$216,779.

RAIDERSBURG. The Black Friday Gold Mining Co. has arranged for Breitung & Co. of New York to operate its property.

NEVADA

According to Frank Manson of the Western Ore Purchasing Co., prospecting and development in this State has never been so extensive. There have been no startling discoveries, but the large output of ores and metals proves that preliminary work is bearing fruit.

GOLDFIELD. An option has been secured on the Kanrohat mine, 6 miles north-east of Round Mountain, by the Jumbo Extension company. The main adit is to be extended 150 ft. beyond its present length of 564 ft. A new 50-ton mill is ready for ore treatment.

The Diamondfield Black Butte company is to explore at depth with a core-drill having a capacity of 2000 feet.

Final figures of the Goldfield Consolidated's August return show that 17,300 tons of ore yielded a profit of \$18,211. Total

costs were \$7.43 per ton. Milling rose to \$2.68 per ton, and while the filter royalty was 1c., flotation royalty increased to 7c. per ton. Development cost \$8.39 per foot over 1664 feet covered.

MANHATTAN. Installation of a compressor at the Bath shaft of the Union Amalgamated has been finished, and the incline shaft is to be deepened 120 ft. Development at a depth of 500 ft. is reported as splendid. The mill is to resume treating mine ore this week. The Big Four and Seyler-Humphrey mines are sending ore to this plant.

ROUND MOUNTAIN. The Round Mountain company states that while the season's supply of water available for hydraulicking placer ground has been exhausted for some time, the management, by adopting new methods, has prolonged the earning period considerably by the introduction of several devices commonly used in building operations. Since the water cannot be brought to the gold-bearing ground, the gravel is hauled by teams and sledges, carried over a bridge, and dumped into the sluice-boxes. This part method of treatment has yielded the highest gold-content for the year. It was commenced early in August, and the total for that month was 2150 yd., with a gross value of \$2.08 per yard. Another small clean-up, made on September 12, yielded 871 yd. with a gross value of \$2.50 per yard. This process will be continued as long as practicable, and will add several thousand dollars to the gross earnings for the season.

TONOPAH. During August the Belmont produced 2232 oz. of gold and 199,445 oz. of silver, from 12,364 tons of ore. The profit was \$92,636. Diamond-drilling has been started in the East End mine, which the company is working under an agreement.

On October 21 the Tonopah Mining Co. pays 15c. per share.

The Jim Butler company's profit in August was \$24,296 from 4532 tons.

The Extension treated 9247 tons at a profit of \$64,506. The yield was 1649 oz. gold and 168,878 oz. silver.

NEW MEXICO

(Special Correspondence.)—High-grade ore was discovered last week at the face of No. 3 adit in the Eureka claim. The owner, D. E. Bearup, has already shipped a considerable tonnage from upper workings and this new shoot adds to the reserves. First-grade ore is being sacked for consignment to the El Paso smelter, while the second class will be treated at local custom works.

At the Pacific mine a large number of carpenters are rushing work on the loading-station and terminal for the aerial tram to the plant of Socorro company, at which latter point the terminal is practically completed. Mine development is being hurried, and the property will be in shape for supplying the tram with a regular tonnage for a long period.

The Eberle mine has been explored with a total of 600 ft. of sinking and raising and 1450 ft. of driving. Both the Queen and Deep Down veins run the length of the property, the former with a width of 4 to 18 ft. The Oaks Company's operations have been confined largely to the latter vein, and a good tonnage of mill ore is opened. Ore was shipped by this company during the development period, with a value exceeding \$2000 per ton. No stopping has been done.

The Mogollon company's output for first half of September was 1300 lb. of silver-gold bullion and 3 tons of high-grade concentrate, from treatment of 2025 tons of ore. A station at 900 ft. in the new shaft is being cut, and will be finished this week, when sinking will be continued.

A 1% dividend was paid on September 1 by the Socorro Mining & Milling Co., the fifth of similar amount this year.

Mogollon, September 19.

TEXAS

(Special Correspondence.)—An investigation into the coal and lignite resources of Texas has just been made under the

direction of the Bureau of Economic Geology and Technology of the University of Texas, and this data, in conjunction with that obtained in similar research by the State Mining Board, affords some interesting information. It is stated that there are, generally speaking, three coalfields in the State. They are known as the Pennsylvania in the north-central part, the cretaceous in Maverick county, adjacent to the Rio Grande, and the territory in Webb county, also bordering the Rio Grande. It is estimated that there are approximately 8200 sq. miles of known bituminous fields of which 5300 sq. miles are possibly productive. The total area, as shown by outcrops and actual development is about 60,000 sq. miles. Up to this time approximately 11,000,000 tons of lignite has been mined here. In the north Texas field the largest daily production of one company is 800 tons of coal. The estimated cost of placing coal on the surface is around \$2 per ton.

Austin, September 17.

UTAH

AMERICAN FORK. Probably no other district in Utah is having the development done by tunneling that is now going on in American Fork canyon, says the *American Fork Citizen*. The excessive snow-fall makes this system of exploration most efficient, besides having the advantage of cross-cutting the different formations and making it more economical to extract the ore when it is opened. The mountains are so precipitous that generally tunneling is a quicker method than sinking. At present the following properties are driving adits: Bay State, South Park, Miller Hill, Whirlwind, Dutchman, Texan, Smuggler, Utah Centennial, Mineral Flat, Red Cloud, Copper Glance, Atlantic, Pacific Extension, American Fork Queen, and Nash in the main canyon; the Belorophan, Miller Hill Extension, and Yankee in the Mary Ellen gulch; the Earl Eagle and Trinman in the Major Evans gulch; the Gold Hill, Mercer, North Star, Mary Elizabeth, Ella May, and Wasatch King in Silver Lake; and the Deer Creek Copper, Stewart, Silver Flat, and Alpine-Empire in the Deer Creek section. Besides these there are a number of others doing assessment work with adits, and several that are sinking shafts or taking out ore from the tunnel-level through winzes, drifts, and raises.

The Utah Power & Light Co. is to extend its transmission-lines to the Fissures Exploration Co.'s Pacific mine, and to the mill under construction on Dutchman flat in American Fork canyon.

FORTUNA. Some rich gold ore is being opened in the Paymal and Frazer mines, while encouraging results are reported from the Fortuna Independence, Fortuna Gold, Gold Queen, and others.

PARK CITY. The Daly Mining Co. is considering the erection of a 150-ton mill to treat lead-zinc ore and a large quantity of filling in old stopes. A hydro-electric plant at the mouth of the Ontario drainage-tunnel is also proposed. E. A. Wall is president of the company.

TINTIC. At the Iron Blossom the winze on the rich copper shoot is being sunk from the 1200 to the 1300-ft. level.

The Eagle & Blue Bell company is to sink from 1876 ft. to water-level, another 200 ft. or so.

A contract is to be let by the Tintic Standard for sinking its new shaft a depth of 1000 ft. Ore is being shipped, and new machinery is ordered.

WASHINGTON

REPUBLIC. A Consular Report gives the following note:

"Recognizing the increasing importance of the valley mining district in Stevens county, the Consolidated Mining & Smelting Co. of Canada has authorized a reduced treatment charge on ores that go to its smelter at Trail, British Columbia, and the Great Northern Railroad has also announced a reduction in the freight-rate, both schedules to become effective about October 1. The reduction rate will be \$1.50 per ton on ore that assays between \$25 and \$50 per ton, and the

freight will be \$2.45, or a total freight and treatment charge of \$3.95 per ton. If ore exceeds \$50 per ton, a proportionate additional charge will be made both on freight and treatment."

NORTHPORT. The Electric Point lead mine is now shipping 100 tons daily. Seventy men are employed. The carbonate ore averages 25%, and the sulphide 70% lead. To September 21 there had been delivered at Trail 2633 tons.

CANADA

BRITISH COLUMBIA

According to Lorne A. Campbell, retiring minister of mines for the Province, the mineral output in 1916 will be between \$45,000,000 and \$50,000,000, which is \$15,000,000 more than the record in 1912. This is largely due to increased prices of metals. Facilities for production have been increased greatly, and plants extended. A lot of new capital was invested and more is seeking an outlet. Labor has been scarce, resulting in labor-saving machinery being installed.

SLOCAN. According to Sidney Norman of Spokane conditions in the Slocan region are better than ever, although labor is lacking and treatment facilities are wanted for the zinc ores.

TRAIL. With a capital of \$1,000,000 the Coast Copper Co. has been organized with headquarters at this place to purchase and option claims and equipment of M. W. Bacon and W. E. Cullen of Spokane in the Quatsino district of Vancouver Island. It is said that the Consolidated Mining & Smelting Co. controls the Coast Copper Co. Recent development has proved extensive orebodies. The property is several miles from June landing on Quatsino sound, necessitating construction of a railway through mountainous country.

TRAVILLE. Butte and Spokane capital is largely interested in this district. This town is reached by wagon-road 10 miles long from the Grand Trunk Railroad, rising in elevation from 746 to 4000 ft. The principal properties are the Rocher de Boule, Highland Boy, Great Ohio, Amargosa, and Red Rose. The first is the largest producer, and is shipping chalcopryite ore regularly. A lower adit, 2700 ft. long, is being driven. D. J. Williams of Butte is manager. Litigation is hindering development at the Highland Boy. Prospects in the other mines are reported to be rather encouraging.

ONTARIO

CORALT. The Beaver Consolidated reports as follows for the quarter ended August 31: Bullion in storage, in ore, and bagged at mine totals 213,906 oz., against 294,183 oz. on May 31. Cash amounts to \$43,921, compared with \$92,184. Two shoots of high-grade ore were found at 400 and 460 ft. in the mine. The lower contact has been reached, and exploration continues on the 1600-ft. level. Tests with flotation are not definite yet. A property is being explored in the Kirkland Lake district.

KOREA

The August clean-up of the Oriental Consolidated was worth \$131,735.—The Seoul company treated 16,725 tons for \$143,319.

COPPER EXPORTS in eight months were as follows.

	1916	1915
United Kingdom	51,738	57,915
France	140,529	62,592
Holland	1,912	798
Italy	31,113	27,916
Denmark	1,901	1,550
Norway and Sweden	8,191	11,586
Russia	12,283	8,651
China and Japan	71	81
Sundries	2,634	1,597
Total	215,199	171,786

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

D. C. JACKLING has gone to New York.

COURTENAY DE KALB is on his way to New York.

J. H. SCHISSLER, formerly at Guanajuato, is here.

H. E. CRAWFORD was here from Los Angeles last week.

E. T. DUMBLE, of Houston, Texas, is at the Plaza hotel.

W. W. MEIN and W. KARRI-DAVIS visited Grass Valley this week.

F. LYNWOOD GARRISON is due to arrive at Philadelphia from Brazil.

F. E. MARCY has opened offices in the Atlas building, Salt Lake City.

HALLET R. ROBBINS has been at Copperopolis, in Calaveras county, California.

F. L. SIZER has been examining mines at Atlanta, Idaho, and is now in the Wood River district.

J. F. MAXNING and EDWIN W. MILLS, both registering from Korea, attended the Institute meeting.

HENXEN JENNINGS, who has spent three months in Alaska and California, has returned to Washington.

HARRY B. BARLING has returned to New York after a professional trip to several of the Western states.

WILLARD S. MORSE has gone to Chuquicamata, presumably to act as resident manager for the Chile Copper Company.

J. H. HOWARD, manager of the Amparo mines, and FRANK W. OLDFIELD, manager of the Cinco Minas, are returning to Jalisco, Mexico.

J. VOLNEY LEWIS has just returned to the East from a trip started on May 1 through the western mining states, British Columbia, and Alaska.

CHARLES E. PHOR, recently at Hedley, B. C., is on his way to Pachuca, Mexico, having accepted an appointment as surveyor at the La Blanca mine.

EDWARD H. BENJAMIN, W. KARRI-DAVIS, and HENXEN JENNINGS have been visiting the Mother Lode mines, motoring from Amador county to Mariposa.

Among the Montana members present at the Institute meeting were W. E. GARY, C. W. GOODALE, E. C. HICKMAN, C. R. KUZELL, E. C. POTTER, R. H. SALES, V. O. STROBEL, H. S. WARE.

EDMUND L. HAYT, for the past six years chief engineer to the Ray Consolidated Copper Co., has resigned to become assistant treasurer and mine manager for the Arizona Ray Copper Company.

KENNETH GUTTERMAN (Columbia '10), son of the late Franklin Gutterman, has been appointed secretary to EUGENE BRADEN, vice-president and local manager for the American Smelting & Refining Company.

At the annual election of the New York section of the Mining and Metallurgical Society, held on September 21, the following officers were elected: W. R. ENGALLS, chairman; W. Y. WESTERLUND, vice-chairman; and D. M. LIDDELL, secretary.

E. P. MATHIASON has resigned as manager of the reduction works of the Anaconda Copper Mining Co. at Anaconda to accept the position of general manager for the British American Nickel Corporation at Sudbury, Ontario, with headquarters at Toronto.

Among the Colorado men attending the Institute meeting in Arizona were the following: A. L. BLUMFIELD, D. W. BRUNTON, CHAS. A. CHASE, SUGRIDER FISCHER, JUSTIN H. HAYNES, V. G. HOLS, E. H. LAWS, P. M. McHUGH, JOHN C. TAYLOR, A. J. WERNING.

THE METAL MARKET

METAL PRICES

San Francisco, October 3.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	29.25
Pig lead, cents per pound.....	7.25—8.25
Platinum: soft and hard metal, per ounce.....	\$90—95
Quicksilver: per flask of 75 lb.....	\$75
Spelter, cents per pound.....	12
Tin, cents per pound.....	41
Zinc-dust, cents per pound.....	20

Antimonial-lead production of the United States in 1915 was 23,224 tons, valued at \$3,665,736. The antimony-content was 15.9%, and lead-content 84.1%.

ORE PRICES

San Francisco, October 3.

Antimony: 50% product, per unit (1% or 20 lb.).....	\$1.00
Chromite: 40% and over, f.o.b. cars California, per ton.....	13.00—15.00
Manganese: 50% (less than 35% metal not bought).....	14.00
Magnesite: crude, per ton.....	8.00
Tungsten: 60% WO ₃ , per unit.....	15.00—20.00

At Boulder, Colorado, tungsten is being bought for \$20 per unit.

New York, September 27.

Antimony: The quotation is unchanged at \$1 to \$1.10 per unit for ordinary ore.

Tungsten: Inquiries are more numerous from both domestic and foreign sources, but most of the buying is for export. Agents of the Allies are reported to be endeavoring to buy direct in the South American market, and business has been done in Argentina for export to France. Business with England is reported to be at a standstill, for the reason that the Minister of Munitions has fixed the price of ferro-tungsten at around 5s. 6d. (\$1.32) per lb., and of tungsten powder at 6s. 3d. (\$1.50) per lb., prices at which the American makers cannot do business. France, Italy, and Russia are paying a higher price for both materials. The quotation is unchanged at \$17 per unit.

EASTERN METAL MARKET

(By wire from New York.)

October 3.—Copper is strong, though quieter; lead is firm, spelter is closely held but fairly active.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Sept. 27.....	69.25
" 28.....	69.12
" 29.....	69.25
" 30.....	69.12
Oct. 1 Sunday.....	69.12
" 2.....	68.87
" 3.....	68.87

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90
Feb.	57.53	48.45	56.74	Aug.	54.35
Mch.	58.01	50.61	57.89	Sept.	53.75
Apr.	58.52	50.25	54.87	Oct.	53.12
May	58.21	49.87	74.37	Nov.	49.12
June	58.43	49.03	65.04	Dec.	49.27

There is little to say regarding the silver market, the above quotations indicating steadiness. Purchases for India have been a feature in a market with restricted supplies. China exchanges showed signs of hardening, and exports from London tend to decrease. The present price is considered a reasonable one.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Sept. 27.....	28.75
" 28.....	28.62
" 29.....	28.50
" 30.....	28.50
Oct. 1 Sunday.....	28.50
" 2.....	28.50
" 3.....	28.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.50	July	13.26
Feb.	14.46	14.28	26.62	Aug.	12.34
Mch.	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.62	Oct.	11.10
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.47	Dec.	12.75

Copper dividends paid during September by 15 producers totaled nearly \$24,000,000. Utah Copper led with \$4,873,470, followed by Kennecott with \$4,166,367; Phelps-Dodge, \$3,600,000; Calumet & Hecla, \$2,000,000; Nevada Con., \$1,999,457; Chatoy, \$1,957,455; Calumet & Arizona, \$1,234,824; Ray Con., \$1,182,847; Copper Range, \$962,968; and Old Dominion, \$880,059. Nearly 12,000,000 shares will receive \$1.99 each.

Champion Copper has declared \$6.40 per share, making \$43.40 for the year. Miami pays \$1.50 per share on November 15. Osceola pays \$5 on October 31, North Butte 75c. on the 23rd, and Anaconda \$2 on November 27. The last amounts to \$4,662,500. Inspiration pays \$2 on October 30.

August outputs were as follows: Chino, 6,326,116 lb., Nevada Con., 7,688,014; Ray Con., 6,597,032; and Utah Copper, 20,315,440 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Sept. 27.....	7.00
" 28.....	7.10
" 29.....	7.10
" 30.....	7.10
Oct. 1 Sunday.....	7.10
" 2.....	7.10
" 3.....	7.10

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.82	5.95	Aug.	3.86
Mch.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.28	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

On October 1 the Bunker Hill & Sullivan company distributed dividend No. 287, of \$31,750.

The U. S. Geological Survey has issued its pamphlet report on lead in 1915.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Sept. 27.....	9.00
" 28.....	9.25
" 29.....	9.37
" 30.....	9.37
Oct. 1 Sunday.....	9.37
" 2.....	9.37
" 3.....	9.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mch.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	16.91	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

New Jersey Zinc Co. will pay an extra dividend of 10¢ on October 10. This makes 62¢ for the year, equal to \$21,700,000. Zinc concentrate, 60% metal, averaged \$55.62 per ton at Joplin during September.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
Sept. 5.....	77.00
" 12.....	75.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50
Feb.	39.00	60.00	295.00	Aug.	38.00
Mch.	39.00	78.00	219.00	Sept.	37.25
Apr.	38.90	77.50	141.60	Oct.	35.00
May	39.00	75.00	90.00	Nov.	35.00
June	38.60	90.00	74.70	Dec.	33.10

TIN

Prices in New York, in cents per pound.

Date.	Average week ending
Sept. 27.....	27.62
" 28.....	28.00
" 29.....	28.00
" 30.....	28.00
Oct. 1 Sunday.....	28.29
" 2.....	28.41
" 3.....	28.56

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	27.85	34.40	41.76	July	31.60
Feb.	29.76	37.23	42.60	Aug.	31.50
Mch.	28.76	48.76	50.50	Sept.	31.10
Apr.	28.10	48.25	51.49	Oct.	30.40
May	33.29	39.28	49.10	Nov.	33.51
June	30.72	40.26	42.07	Dec.	33.60

Tin is steady at 39.50 cents.

Eastern Metal Market

New York, September 27.

All ordinary features in copper were eclipsed by the closing last week of a contract whereby the Allies agreed to take 200,000 gross tons, or 448,000,000 lb., of electrolytic copper, delivery to be over the first half of 1917, at a price somewhere between 26 and 27c. The quantity represents about one-third of the United States production of the period. It is generally considered that the ultimate effect of this enormous purchase will be to steady the metal, inasmuch as it will take the Allies out of the market for months to come, and leave it to domestic influences. The copper that the neutral powers of Europe will buy will not count for much.

Zinc is quieter and lower, but ultimately it is thought that the Allies will buy extensively.

Lead has steadied around 7c., New York, the quotation of both the leading interest and the independents.

The inactivity in tin has disappointed sellers.

Antimony continues lifeless, with prompt metal at 11c., duty paid.

Aluminum is quoted at 62 to 63c. per pound.

COPPER

Late last week protracted negotiations were closed, and on Saturday, September 23, it was announced that Great Britain and her Allies had placed a contract with the leading American copper producers whereby the latter are to supply the Entente powers with 200,000 gross tons, or 448,000,000 lb., of electrolytic copper, delivery to be distributed over the first six months of 1917. Reports differ as to the price. In many directions it is persistently asserted that 26.50 to 26.75c., seaboard, is to be paid, but the reported total amount involved—\$120,000,000—indicates that the average price will be about 26c. With certainty it can be said that the consideration actually was between 26 and 27c. per lb. J. P. Morgan & Co., fiscal and purchasing agent for Great Britain, acted for the Allies, while the producers' interests are understood to have been looked after by John D. Ryan, of the Anaconda Copper Mining Co., and Joseph Clendenin, of the American Smelting & Refining Company.

According to the terms of the contract the Allied governments will take about one-third of the copper produced in the first half of 1917. Evenly distributed, exports on the contract will approximate 33,000 tons per month. To this quantity must be added that to be taken by the neutral powers, so that it is safe to predict that monthly exports in the first half of next year will break all records. The monthly exports averaged 22,559 tons in 1915, 30,919 tons in 1914, and 31,901 tons in 1913 the record year. In the first six months of 1916 exports totaled 147,913 tons, of which the Allies took 136,635 tons, and in the same period of 1915 exports were 136,527 tons, of which these Powers received 123,373 tons.

Members of the trade are of the opinion that the big contract will exercise a healthy influence on the market. They believe the elimination of the Allies from the situation for many months to come will steady the market, render it quiet, but strong, and make it possible for the domestic consumer to buy into the future without risk of serious loss. Should there develop an exceedingly heavy demand from industrial consumers the market might advance, but at present prices, further large buying for the arts of peace is not considered to be likely. Even at present prices there is a tendency to find substitutes for the metal. The combined buying of war contractors and industrial consumers has been heavy in the last week, the impending contract with the Allies having caused a rush to cover first quarter, and first half requirements, although less activity followed the announcement of

the big deal. Considerable variation in quotations continues. Those for electrolytic yesterday (September 26) were about as follows: Prompt, 29c.; October, 28.75 to 29c.; last quarter, 28; and first quarter, 27.25 to 27.75c. Lake is unobtainable for early delivery, the December position being quoted at 28c. The London quotation for electrolytic yesterday was £138, against £135 10s. a week previous. The Allies now have control of the foreign market. Exports from September 1 to 27 totaled 21,851 tons.

ZINC

Business tapered off in the early part of last week, and has since been spotty, with quotations on the downward trend. Early last week a few hundred tons were taken by Canadian buyers, but there is little else to report. Prompt was quoted yesterday at 9c., New York, and 8.75c., St. Louis, with last quarter ranging from 8.50 to 8.62½c., St. Louis. The trade is firm in the belief that the Allies will sooner or later come into the market for a large quantity in conjunction with the copper to be delivered over the first half of 1917. It is recognized that weeks or months may elapse before this business comes. Exports are heavy, those of September, up to and including the 26th, amounted to 10,591. The total exports in 1913, the last year preceding the War, in plates, sheets, pigs or bars, amounted to but 7783 tons. This quantity jumped to 61,802 tons in 1914, and 98,973 in the first 10 months of 1915. The spot quotation at London yesterday was £52, against £56 a week previous. Sheet zinc is unchanged at 15c. per lb., carload lots, f.o.b. mill, 8% off for cash.

LEAD

Whereas a few days ago independent producers were asking premiums of 5 to 15 points for prompt lead, they are now offering freely at 7c., New York, the quotation of the A. S. & R. Co. The leading producer asks 6.92½c., St. Louis, and independents quote 6.85c. Canadian purchasers last week took round lots of prompt and early delivery metal, and are still in the market, and this activity provides about the only feature of note at present. On the rise of the market consumers bought extensively, but stopped when independents endeavored to get over 7c. Meanwhile the market is quiet and steady. It is noted that consumption and production are fairly evenly balanced, and only a moderate demand will serve to impart strength to the market. Exports are proceeding at a good rate, amounting this month, up to yesterday, to 4416 tons. The London quotation for spot yesterday was £31 10s., against £30 15s. a week previous.

TIN

The heavy buying for which tin-brokers have been looking has not materialized, and they do not hesitate in saying that they are disappointed. On one or two days activity has been fair, as on September 21, when 100 tons changed hands, and the following day, when 300 tons was taken. The interest was almost entirely in future positions, some as far ahead as June, nearly metal being neglected. Banca has sold to a limited extent every day. Two reasons are vouchsafed for the inactivity of large consumers: one is that the tin-plate price for next year has not been fixed, and manufacturers are awaiting its adjustment; while another is that consumers accumulated reserve stocks a few months ago when the future appeared uncertain, and they are now using this metal. When buying does start, it would not be surprising to see a run-away market. The spot price for Straits tin yesterday was 38.6 c. On September 26 there was afloat 2960 tons, and up to yesterday 2750 tons had arrived.

Recent Publications

U. S. Geological Survey, Washington, D. C., 1916:

SURFACE WATER-SUPPLY OF THE UNITED STATES, 1913. Part XII, North Pacific Drainage Basins; B, Snake River Basin. P. 290. Index.

MOLYBDENITE AND NICKEL ORE IN SAN DIEGO COUNTY, CAL. Papers by F. C. Calkins. Bulletin 640-D. P. 10. Illustrated.

TIN ORE IN NORTHERN LANDER COUNTY, NEVADA. By Adolph Knopf. Bulletin 640-G. P. 14. Map.

AN ANTICLINAL FOLD NEAR BILLINGS, NOBLE COUNTY, OKLAHOMA. By A. E. Fath. Bulletin 641-E. P. 18. Map.

OIL AND GAS GEOLOGY OF THE FORAKER QUADRANGLE, OSAGE COUNTY, OKLAHOMA. By K. C. Heald. Bulletin 641-B. P. 31. Maps.

STRUCTURE OF THE VICKSBURG-JACKSON AREA, MISSISSIPPI. With special reference to oil and gas. By Oliver B. Hopkins. Bulletin 641-D. P. 28. Maps.

MINERAL RESOURCES OF ALASKA. Report on progress of investigations in 1915. P. 279. Ill., maps, index. Many abstracts have already been made from this useful publication.

LOWER EOCENE FLORAS OF SOUTH-EASTERN NORTH AMERICA. By E. W. Berry. Professional paper 91. P. 481. Ill., and 117 plates, index.

A RECONNAISSANCE OF THE ARCHEAN COMPLEX OF THE GRANITE GORGE, GRAND CANYON, ARIZONA. By L. F. Noble and J. Fred Hunter. Professional paper 98-I. P. 19. Illustrated.

NORTH AMERICAN UPPER CRETACEOUS CORALS OF THE GENUS MICRABACIA. By L. W. Stephenson. Professional paper 98-J. P. 17. Illustrated.

SOME PALEOZOIC SECTIONS IN ARIZONA AND THEIR CORRELATION. By F. L. Ransome. Professional paper 98-K. P. 34. Ill., maps.

THE CATAHOULA SANDSTONE AND ITS FLORA. Papers by G. C. Matson and E. W. Berry. Professional paper 98-M. P. 43. Illustrated.

MECHANICS OF THE PANAMA-CANAL SLIDES. By George F. Becker. Professional paper 98-N. P. 9. Illustrated.

U. S. Bureau of Mines, Washington, D. C., 1916:

BLACK DAMP IN MINES. By G. A. Burrell, I. W. Robertson, and G. G. Oberfell. Bulletin 105. P. 88. Index.

METHODS OF SAMPLING DELIVERED COAL. Specifications for the purchase of coal for the Government. By George S. Pope. Bulletin 116. P. 64. Ill., chart, index.

HISTORY AND DEVELOPMENT OF GOLD DREDGING IN MONTANA. By Hennen Jennings. With a chapter on 'Placer-Mining Methods and Operating Costs,' by Charles Janin. Bulletin 121. P. 63. Ill., plans, index. An abstract of this appeared in the Press of September 23.

CONSTRUCTION AND OPERATION OF A SINGLE-TUBE CRACKING FURNACE FOR MAKING GASOLINE. By C. P. Bowie. Technical paper 161, petroleum technology 35. P. 16. Ill., plans.

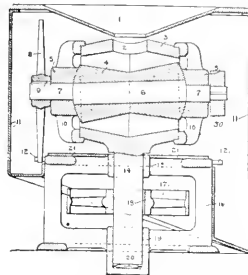
MAGNETIC PROPERTIES OF COBALT AND OF Fe_3CO . By Herbert T. Kalmus and K. B. Blake. P. 18. Ill., charts. Department of Mines, Ottawa, Canada, 1916. This is part 5 of researches into cobalt and cobalt alloys, conducted at Queen's University, Kingston, Ontario.

CYPELLATION LOSSES IN ASSAYING. By H. T. Mann and C. Y. Clayton. P. 60. Charts. Bulletin of School of Mines, University of Missouri, Rolla, 1916. An abstract of this useful data appeared in the Press of September 23.

COAL RESOURCES OF THE CLINTWOOD AND BUCK QUADRANGLES, VIRGINIA. By Henry Hinds. Bulletin No. XII. P. 206. Ill., maps, charts, index. University of Virginia, Charlottesville, 1916.

Recent Patents

1,191,564. **ROCK AND ORE BREAKER.** Thomas W. Capen, Milwaukee, Wis., assignor, by mesne assignments, to Allis-Chalmers Manufacturing Company, a Corporation of Delaware. Filed June 27, 1910. Serial No. 568,990.



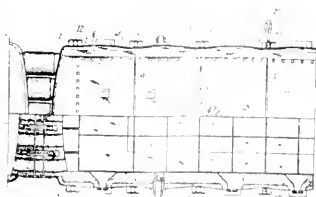
1. In a rock and ore breaker, an annular body, means for supporting said body to rotate on an axis at an angle to its axis of annularity, a head within said annular body forming with said body coating breaking elements, means for rotating said body on said axis at an angle to its axis of annularity, and means for moving one of said breaking elements relative to the other to cause their breaking surfaces to approach and recede from each other.

1,193,190. **CONCENTRATOR.** Clinton B. Ripley, Joplin, Mo. Filed Nov. 10, 1915. Serial No. 60,702.



1. In a concentrator, a longitudinally reciprocatory table-deck, stationary bearing sockets arranged near the ends of the table-deck, bearing studs connected with the ends of the table-deck and mounted to reciprocate within the bearing sockets, yielding means connected with the table-deck and serving to wholly support the same and hold the bearing studs up in slidable contact with the bearing sockets, and means to reciprocate the table-deck.

1,193,109. **FURNACE-BINDING.** James A. Bow and Peter Thill, Great Falls, Mont., and Archer E. Wheeler, London, England. Filed Dec. 17, 1914. Serial No. 877,707.



1. In combination with a furnace having an arched roof and supporting walls therefore, a series of buckstays distributed at intervals around the walls and terminating at the top of the walls, a fixed support, and flexible means carried by said support for maintaining the upper portions of the buckstays in permanent engagement with said walls.

In the week ended September 19, 610 patents were gazetted.

Company Reports

BLACKWATER MINES

This is the most important gold mine in the South Island of New Zealand. According to the general manager, V. Hartog, development amounted to 5000 ft. at a cost of \$12.97 per foot. Ore reserves are estimated at 91,251 tons, averaging \$11.23 per ton over a stoping width of 31.86 in. Mining cost \$3.32 per ton, including 38c. for hoisting and 8c. for pumping.

The mill treated 54,643 tons of ore, yielding \$8.60 per ton by amalgamation, \$1 by cyanidation, and 56c. from concentrate, a total of \$10.16 per ton. The recovery totaled 89.08%. The total value was \$115,611 (\$557,000). Costs were as follows: ore transport, 2c.; rock-breaker, 2c.; stamping, 26c.; tube-milling, 6c.; concentration, 4c.; cyaniding, 28c.; a total, with sundries, of 69c. per ton.

The year's profit was \$62,048 (\$298,000), of which \$120,000 was distributed in dividends. The credit balance is \$77,000.

ZINC CORPORATION

This company operates the South Blocks mine at Broken Hill, Australia, and buys and treats by flotation old tailing from the other mines. The zinc flotation plant was not operated on account of the War interfering with sale of concentrate.

Mine development consisted of 4932 ft., including 1548 ft. of diamond drilling. The main shaft is 1433 ft. deep. Reserves are estimated at 1,591,211 tons, averaging 14.8% lead, 2.5 oz. silver, and 9.2% zinc, an increase of 318,341 tons.

In 247 days the lead concentrating plant treated 154,628 tons of ore of almost the above average, yielding 31,397 tons of concentrate, 61.1% lead, 9.1 oz. silver, and 7.1% zinc.

The year's profit was \$675,000. Dividends were paid on common and preferred shares. The sum of \$480,000 was spent in buying shares of the Broken Hill Associated Smelters Proprietary.

WAIHI GOLD MINING CO.

The superintendent, E. G. Banks, of this, the largest gold and silver producer in New Zealand, in the North Island, reports as follows for the past year.

The principal work in the mine was in opening No. 11 level, on which 5577 ft. of development was done. This opened considerable quantities of ore. No. 4 shaft was sunk 171 ft. to the 1470-ft. level. Total exploration amounted to 17,681 ft. Ore reserves increased 230,043 tons to 673,896 tons. The Cornish pumps (Hathorn-Davey) lifted 85,945,450 gal., and the electric pumps 217,024,241 gal. of water. A turbine pump was installed on the 1309-ft. level. Seventy drills, mostly of the stoping-hammer type, are in use.

In the 200-stamp mill, 6 miles by rail from the mine, an average of 113,131 stamps and 7,925 tube-mills (total 11) reduced 192,333 tons of ore, averaging \$7.76 gold and 2 oz. 12 dwt. silver per ton. The residue contained 56c. gold and 9 dwt. of silver. The recovery value was 91.2%.

Concentrate assayed 9 oz. 19 dwt. 15 gr. gold and 49 oz. 2 dwt. 7 gr. of silver per ton. The extraction from this was 97.7%. There was melted 67,069 lb. of zinc-gold slime, yielding 531,190 oz. of doc bullion. The refinery produced gold 999.5 and silver 999.9 fine.

The year's revenue totaled \$363,679 (\$1,770,000). Cost totaled \$5.20 per ton, including office, taxes, fees, etc. Dividends (4 of 21c. each), totaled \$189,000. Investments at cost amount to \$1,820,000.

The hydro-electric plant, 50 miles away, costing \$941,000 generated 12,597,649 units. It operates on the Waikato river and the 200-ft. high on-line cross plains and a curved range over 2000 ft. high on steel towers.

Industrial Notes

Innovation supplied by the manufacturers.

In Bulletins 100, 101, and 102 of the STOW MANUFACTURING Co., Binghamton, N. Y., are described electric motors, portable electric tools, and the Stow flexible shaft with its many applications, respectively. To mine mechanics these publications are of interest.

In Bulletin No. 125 the JOSHUA HENBY IRON WORKS of San Francisco talks about Matteson mine-cars made by this firm. Important features of design are pointed out in red. The compound hinge allows the body of the car to be tipped to an angle of 10°, allowing for dumping on either side. Hyatt roller-bearings are fitted on the axles. Specifications are given for several types of cars.

The GENERAL ENGINEERING Co. of Salt Lake City has been employed by the Consolidated Coppermines Co. to re-construct the Gironx concentrator at Kimberly, Nevada, to treat 500 tons per day of Coppermines' ore. The treatment in the re-constructed plant will be by Callow flotation, followed by table concentration. Work started on September 8, and is in the direct charge of Walker J. Boudwin, one of the firm's engineers. About 60 men are now employed at the mill.

As a guide for mill-men, rather than for metallurgists, the GENERAL NAVAL STORES Co. of New York has issued a booklet which outlines the frothing and foaming properties of various kinds of oils, with suggestions for combining them to successfully treat a given ore. The publication really summarizes the company's observations on oils as applied to flotation. Details are given on the properties of G. N. S. flotation oils, and oil-mixtures. Interesting notes are presented on frothing agents, including pine-oils, coal-tar creosotes, coal-tar, and sludge-acid. Flotation oils may be divided into two general classes, namely, frothing agents and oiling or collecting agents.

Aerial tramways recently supplied by A. LESCHEN & SONS Rope Co. of St. Louis were as follows: Queen of the West Mines Co., Cornucopia, Oregon. A gravity two-bucket tram 3200 ft. long, the line having a fall in this distance of 1456 ft. This tramway will have a capacity of 6 tons of ore per hour, and replaces a single-line tram of another manufacture.—Cottonwood Coal Co., Lehigh, Montana. A two-bucket tram for the disposal of waste. This line has a length of 800 ft., and carries at the rate of 20 tons per hour. The tram has 1½-in. diam. special-steel track-ropes, and a ½-in. diam. traction-rope. The carriers are of 24-in. ft. capacity. The material is dumped by means of an aerial trip at any point along the line.

It has been said that the average person thinks of pipe merely as "a piece of steel with a hole in it." The NATIONAL TUB. Co. of Pittsburgh states that the widely ramifying use of tubular products is one of the romances of this country. Some of the uses of pipe are as follows: agricultural implements, automobiles, bedstead and hospital furniture, architectural iron work, grill work, building columns, refrigerating machinery, dry-kill apparatus, elevator cars, fence posts, ornamental fences, flag-poles, gymnasium apparatus, wheel-barrows, work benches, ornamental gates, elevator grain-spouts, invalid chairs, irrigation systems, safety ladders, loom cylinders, warship masts, lighting and high-tension poles, playground apparatus, electric-wiring conduits, railway-signal apparatus, spooling tube, lunch-counter stools, sprinkler systems, signal-towers, and at many places around mines and mills. There has been a decided change in material, as 50 years ago nearly all of the screw joint pipe was wrought iron. In 1905 the wrought iron and steel pipe amounted to 452,797 and 938,198 tons, respectively. In 1915 this was 262,198 and 2,037,266 tons, showing the great increase in steel for pipe. The company is erecting a new 600,000-ton per year plant at Gary, Indiana.

EDITORIAL

T. A. RICKARD, Editor

CARRANZA has abolished the vice-presidency of Mexico by decree, yet he remains First Chief of the Constitutionalist Party. The lack of a sense of humor is at the back of many calamities that befall mankind.

THE passing of resolutions demanding the development of our foreign trade is a sign of the times, but the learning of Spanish, Russian, and French would be a more effective means to that end. In linguistic preparedness we are a provincial people.

IT is reported that the management of the Granby Consolidated and other American mining companies operating in Canada are satisfied that no drastic action will be taken by the Dominion authorities in the matter of taxation. We published letters on the subject in our last issue.

SPEAKING of apex suits, the judge in the Phoenix Reef case in London, to which we referred recently, has become so wearied by the interminable wrangle that when the defendant's counsel said something about "the strike of the reefs," he interjected: "Strike! That is what I shall do if this case does not soon finish."

ONE of the notable episodes of the recent Institute meeting in Arizona was the luncheon given by the Calumet & Arizona Copper Company. This was served on tables arranged under the dust-chamber adjoining the blast-furnaces. The cleanliness of the extemporized luncheon-room was typical of the whole smelter-plant.

MINING engineers all over the world will be sorry to hear of the death of Bedford McNeill. To some of them he will be known only as the compiler of a useful code-book, but to many he was endeared as a kind and helpful friend, a good citizen, and an upright engineer. In London, where he lived, he will be missed as a sagacious co-operator in every kind of useful professional organization. He leaves an honorable name and a sweet memory.

APPEALS for subscriptions for the memorial to Joseph A. Holmes are being made by a committee that includes representatives of all the principal scientific and engineering societies. Twenty-two national societies are taking part in the organization, called the 'Joseph A. Holmes Safety Association,' of which Mr. Van H. Manning is president. One of the vice-presidents is Mr. Samuel Compers, representing the American Federation of Labor, and one of the members of the ex-

ecutive committee is Mr. Hennen Jennings, representing the American Institute of Mining Engineers. The intention is to award annually one or more medals, with honorariums, for the encouragement of those originating or developing safety devices or methods. The profession is invited to subscribe, sending their subscriptions to the honorary secretary, Mr. David T. Day, at Washington.

COPPER production during the first half of next year is anticipated to reach a total of 600,000 tons or as much as the refinery capacity in the United States. The recent sale of 200,000 long tons to Great Britain is equivalent to one-third of the output of metal to be made in this country during the first half of 1917, this deal calling for deliveries beginning in January next in monthly installments of 75 million pounds.

IF the news printed concerning conditions in Mexico were reliable, the public would be well informed, but it is not. For example, the *New York World* publishes a long story by a special correspondent and we might accept it as a fairly accurate picture, but the *San Francisco Examiner* re-prints it with a hasty endorsement and at once we doubt the truth of it. Mr. Hearst's paper is so prone to verbal inexactitudes that its statements have become uninteresting.

MR. WARBURG suggests that it is ridiculous for a country owning over two and a half billions of gold not to mobilize a larger free gold reserve than two or three hundred millions of dollars. Is it not equally ridiculous for a country having such natural gold resources in its mines and prospects not to stimulate the output of metal from them? The fact that 60% of the world's output of gold is produced under the British flag is peculiarly fortunate for Great Britain at this time. We produce only 20% of the world's output, but we ought to be producing a great deal more. National interest demands that mining of gold be encouraged in every way possible.

REFERRING to the unexplored mining area in the Far East Rand and the desire of the South African government to interest capital in the exploitation of this promising tract, we note that the Union Government is calling for tenders of lease on two areas covering 1812 and 651 claims, equivalent to 2718 and 976 acres, respectively. In the first lease \$4,000,000 is required for shaft-sinking and \$3,500,000 more for bringing the property to a productive stage; in the second lease a sum of \$1,500,000 is required for shaft-sinking and other

preliminary development, and a further sum of equal amount to bring the property to production. On this occasion an underwriting commission of 5% is allowed, but no vendor's or promoter's shares are to be created. It is probable that the Government has some intimation that tenders will be forthcoming, otherwise the advertisement would not have been made. Meanwhile the Labor party wants the Government to mine the undeveloped territory on national account, and the big financial groups in London or Johannesburg insist that the terms granted heretofore by the Government are not sufficiently attractive. Will the American syndicate bite? We believe not.

ON another page we give the first part of the opinion handed down by Judge Bradford in the suit of Minerals Separation v. Miami Copper Company, tried last year before the U. S. District Court of Delaware, at Wilmington. The decision is belated, for the trial ended in May 1915, so it is to be presumed that the Court has taken great pains to understand the technical issues raised in the course of the trial. The opinion is expressed in language that must command intellectual respect, the wording is clear and well chosen. We shall reproduce the essential portions of the text, omitting sundry paragraphs of an explanatory character aimed to help a reader not versed in the technology of concentration processes in general, or of flotation in particular. Owing to the exigencies of space we shall also omit a long description of the process appearing in patent No. 835,120, the references to the Fryer Hill publication, a lengthy excerpt from the Cattermole patent No. 777,273, another from the Kirby patent No. 809,959, and a summary of the British litigation over the Elmore bulk-oil process, which plays no part in the present flotation litigation. The first part of Judge Bradford's opinion covers the main issue; the second part, which deals with subordinate, but important, questions, will appear in our next issue, together with our own comment on the decision as a whole.

TEN years ago distillation was practically the sole method used in the extraction of zinc from its ores and concentrates. Development of hydro-metallurgic processes has advanced since then at so swift a pace as to offer a formidable challenge to the supremacy of the expensive furnace method. The Brunner Mond works in England are well known, where calcium chloride waste from alkali manufacture constitutes a source of active chlorine for dissolving the zinc as chloride from roasted ores, the metal being electrolytically deposited from this solution, yielding spelter more than 99.5% pure. Electrolytic zinc from sulphate solutions has been produced for many years in Germany and Russia, but the details of the industrial electrolysis have not been accessible, having been guarded in the medieval fashion as a trade secret. At Trail, British Columbia, the Consolidated Mining & Smelting Company of Canada is now producing zinc from complex ores by a method depending on these general reactions, without concealment

under a cloak of mystery. This will be the subject of an article in one of our forthcoming issues. Meanwhile we note a reference to the Isherwood process in the *Financial Times*, London. This process has much in common with the one employed by Mr. E. H. Hamilton at Trail, depending primarily upon the fact that zinc oxide is readily soluble in solutions of zinc sulphate under pressures ranging from three to fourteen atmospheres. Thus the roasted ore, treated with weak sulphuric acid, dissolves some zinc as sulphate, which in turn becomes the solvent for the remaining zinc oxide in the calcine, and is furthermore accommodating enough to discriminate against iron, which latter under the conditions of temperature and pressure maintained is scarcely touched. In the plant at Trail the reactions are obtained at normal pressure, and the solutions seldom contain in excess of 0.008% iron. An exceptionally pure spelter is the natural result.

STRIKES for higher wages in gold-mining districts are prompted mainly by sympathy with copper-mining regions, where the scale of wages is based, in large measure, on the price of copper. This, of course, works a hardship on the operators of gold mines; they are paying more for their supplies, from chemicals to machinery, than before the War, and are gaining no advantage from the big trade in munitions. Indeed, gold has depreciated in value as measured by the supplies, implements, or food that it will buy. On the other hand, the general cost of living has advanced 38% during the past twelve months, so that the miner's wages do not go as far as they did in the purchase of necessities. Evidently the employer and the employee on a gold mine are both suffering injury from the War and they should know enough concerning the basic facts to be considerate of one another. The strike at the Mother Lode mines of California is 'petering out,' we are informed, and we are aware of no reason why it should not. Some of the mining companies raised wages voluntarily last year and showed a fair spirit in the matter; it is a pity to make trouble through demands that are not just nor likely to be justified.

ANNOUNCEMENT is made that Mr. Fred. Hellmann has been appointed consulting mining engineer to the Guggenheim Brothers. The news is interesting, for Mr. Hellmann has many friends in the West that recognize the ability he has exhibited both in South Africa and Chile; but the announcement is also noteworthy by reason of the new style of the Guggenheim family firm: Guggenheim Brothers succeeding M. Guggenheim & Sons. When Meyer Guggenheim had created a big mining and smelting business he passed it to his sons, of whom there were seven, and now there are six, Isaac, Daniel, Murry, Solomon, Simon, and William. The youngest is not in the organization; in fact, he is conducting a bitter lawsuit over the division of profit in the Chuquibambata deal. Benjamin Guggenheim went down on the *Titanic*. Meyer Guggenheim, the founder

of the *haute finance* of American mining and metallurgy, landed at Philadelphia as a poor immigrant from Switzerland in 1847 and died in 1905. He was a man intensely acquisitive of information, shrewd, and hard-working. Beginning life as a dealer in lace, he lent money on a note that brought him eventually into the control of the A. Y. and Minnie mine at Leadville. Then he joined the enterprising 'Ed.' Holden in building the Philadelphia smelter at Pueblo and thus got a foot in the smelting business. By that time his lace business had enriched him so that he was able to transfer this smelting venture to his sons under the style of M. Guggenheim's Sons, not Meyer Guggenheim & Sons. How the smelter in Colorado became the first unit of an immense business we all know. Two of his grandsons are now in the organization, namely, Harry the son of Daniel, and Edmund the son of Murry, these younger men being in the employ of the Chile and Braden copper companies. The inheritance left by the founder has been developed and expanded by his sons until it has become synonymous with skillful and successful operations on the biggest scale known to the modern world.

Flotation in the South-West

In this issue we publish an article by Mr. David Cole on flotation practice in the Clifton-Morenci district and in preceding issues we have given our readers lengthy excerpts from the paper by Dr. Rudolf Gahl on the history of the flotation process at the Inspiration mine. These were the outstanding papers on the subject as discussed at the recent meeting of the American Institute of Mining Engineers, more especially at the session held at Globe. The metallurgical success achieved by the flotation process at Inspiration is romantic in its completeness. While a mill was being designed to treat the ore from a new and promising mine, the Minerals Separation company, then little known in Arizona, requested an opportunity to demonstrate the frothing process. On the request being granted, a 50-ton flotation unit was erected by the side of the existing test-mill. That was in 1913. Three years later the Inspiration is treating 16,500 tons daily by flotation and all of the machinery in the original mill-building, except three electric cranes, has been scrapped. Dr. Gahl gives the total cost of milling at 40 cents per ton, of which one-half represents crushing and grinding of the ore. The expense of flotation treatment alone—labor, oil supplies, and power—amounts to only 5.76 cents per ton. Royalty is not included in any of these figures, it ranges from 7 to 12 cents per ton, according to the tonnage. The recovery on the sulphide copper minerals is about 92%, but the average is reduced to 74% by the presence of some oxidized ore, on which the recovery is only 20%. In short, the metallurgical treatment is not yet perfected. It is noteworthy that a better recovery is made on pulp of minus 200-mesh than on the coarser product; this is nothing new in gold-milling, but it serves to emphasize the fact that the slining of copper ore is not a

detriment, and thus marks the great divergence of practice between flotation and the old wet-concentration methods. As to machines, the Inspiration staff tested a number of them, finally evolving one of their own design that did better work than any other. It was modeled on its predecessors, the Callow, Flinn-Towne, Cole-Bergman, and Hebbard apparatus. In its final form it approaches the ideal of a launder with a porous bottom. It is made of steel; all pipe-connections are from above and therefore readily visible; an air-tight joint is established where the pipe passes through the porous medium into the air-chamber. The consumption of air is 11.8 cubic feet per minute per square foot of porous surface. Various substitutes for canvas were tried; for example, sheets of rubber and rubberized canvas, and the results were encouraging, but not conclusive. As regards flotation agents, the *hocus-pocus* of special mixtures of oils was early disproved by experiment, to the discomfiture of the 'experts.' A man that claims to be an 'expert' in a process as yet so little understood as flotation deserves an iron cross. After using cresylic acid 98% pure and grumbling at even a 2% shortcoming, it was suggested by the frankly non-expert metallurgist that cresylic acid might not represent the particular fraction from coal-distillation that was most useful in a flotation-cell. So tar was distilled from a sample of ordinary soft coal, from New Mexico, and this home-made coal-tar proved an excellent flotative agent. Cresylic acid produces a froth with less carrying power, apart from its expense. Even coal-tar creosote was rejected finally in favor of crude coal-tar, which is the cheapest and best flotation agent, for Inspiration ore, if added to the ore while in the grinding machines, so as to ensure thorough emulsification with the pulp. Incidentally, we may mention that the Inspiration ore is a schist containing 1.17% copper in the form of chalcocite, and a little chalcopyrite, with 0.39% more copper as a carbonate or silicate. In August the mill-feed averaged 1.56% copper and the concentrate 30.22%, while the tailing contained 0.417%, of which 0.325 was oxidized mineral. The weight of flotation agent (coal-tar) averaged 1.31 pounds per ton of ore milled.

Coming to Mr. Cole's paper, which we reproduce in full, it will be noted that he furnishes details of the C-B machine devised by himself and Mr. Julius Bergman. It was designed to overcome a defect noted in the operation of the Flinn-Towne machine, the distinctive feature of which is a round disc of carborundum, serving as a porous diaphragm at the bottom of a cylindrical vessel. The sand had a tendency to lie upon the carborundum and impede the passage of the air, so Messrs. Cole and Bergman substituted a set of perforated tubes covered with a porous fabric, such as canvas or flannel. This invention followed upon the successful application of a tube-grate air-filter in the drag-belt trough, as Mr. Cole explains in detail. Thank heaven! the devising of new machines for flotation is not under the embargo of the Patent-Office. Most of them are modifications of older devices and none of them seems to be essential to

the successful operation of the process. Froth can be made in many ways. At Chino, the Janney machine is paramount. There the notion of strenuous stirring is in the ascendant. 'Emulsification' is the pass-word. Nevertheless, it is to be noted that pneumatic treatment has been introduced into the spitzkasten part of the Janney machine. This is said to save power. But the latest feature of the Chino Copper Company's operations at Hurley is the new process for treating oxidized ore. An experimental plant of two tons capacity is trying a combination of leaching and flotation. The ore, which contains both oxide and sulphide copper minerals, is ground to 80-mesh in a tube-mill and then fed to a table that removes the coarser grains of sulphide. The reject from this table goes to a tank in which it is leached with a weak solution (3 pounds of acid per pound of oxidized copper) of sulphuric acid. It is stated that the 'digestion' of the copper oxide is rapid. The 'digested' pulp is fed then into a cylinder filled with iron-turnings and rotated, so as to prevent the settlement of sand and hasten the precipitation of the copper on the iron, which is thus kept bright and clean. In passing through this cylinder the copper is precipitated completely and the acid is neutralized at an expense of two pounds of iron per pound of oxidized copper. The neutralized copper and the sulphide are then alike in a fine state of division and readily amenable to recovery in a flotation-cell. Credit for this new departure is due, we understand, to Dr. H. W. Morse. Evidently the South-West, which is now the greatest copper-mining region in the world, is destined to contribute its share to the new metallurgy. More records of progress will be forthcoming; so we venture to suggest to writers on the subject that they should start their accounts of milling methods or metallurgical experiments with a plain description of the ore in question. To those living in Arizona or New Mexico the character of the ore at Miami or Chino is known, but to those living in distant localities and reading the papers of our technical friends in the South-West it is a great boon to be told exactly what is the chemical composition and petrographic character of the ore, for purposes of comparison.

Those Copper Quotations

Reverting to this interesting subject, we note that Mr. Walter Douglas, in a letter widely published, mentioned that rumors had reached him that "the large copper-producing interests have financial control of the *Engineering and Mining Journal* and that it is naturally to their interest that the copper quotations therein should be under, rather than over, the market, on account of the bearing which it has on the sliding wage-scale. Did this condition obtain, which it does not, the copper producer or seller would be injuring himself through the publication of such a quotation, as whereas a portion of the high price of copper goes to labor, a greater proportion goes to the producer, and it is obvious that the producer will obtain as much as he possibly can for his output and not give the purchaser and consumer

the impression that the price of copper is lower than that which he is asking for it." As to the sinister suggestion mentioned at the beginning of Mr. Douglas's statement, we believe it to be as baseless as he believes it to be. The *Journal* used to be independent of any smelting or mining company, and we have not the least reason to believe that it has divagated from that attitude of detachment. However, we do believe in the unconscious influence of propinquity and consider it not unfair to infer that a paper published at New York will reflect the ideas current in an environment of metal-sellers. The argument offered by Mr. Douglas is one that we cannot follow. Do the producers sell their copper on the *Journal* figures? Of course not, they bargain with the buyers and brokers. The smelting companies buy ore from the smaller producers on the basis of the *Journal* figures, but the smelters sell on the best figure they can get through their own selling agencies. How a low quotation reducing the wages paid to the miners would injure the copper-producing company, in the manner suggested by Mr. Douglas, we do not understand. Apparently Phelps, Dodge & Co. does not sell on the *Journal* figures if the average price received by that company in 1915 was 16.05 cents as against a *Journal* average of 17.27 cents. On the contrary, we see no reason why the smelting companies should not have settled for wages to the miners and bought ore from the mine-owners on the *Journal's* July average of 23.86 cents while selling its own copper at New York on the average reported by us as having been 25.66 cents. We are at a loss to understand why a labor-union or a mining company should agree to base its scale of wages or its settlements for ore upon the guess of a single trade paper, when the suggestion of this arbitrament comes from the buyer of the labor and of the ore.

It is about time to discover some better method of adjustment between buyer and seller. Why not base the wage-scale and the ore-settlement alike on the price that the mining or smelting company gets for its copper? Why depend on the guess of any trade paper when the essential fact can be ascertained by reference to an authentic record, namely, the books of the copper producer or the smelter, as the case may be? What does it matter to the manager of the Little Bullion mine what other people are getting for their copper? He settles with the smelter on the basis of the price that the smelter is supposed to get for the copper that it buys from him. What does it matter to the copper miner at Bisbee what the Anaconda company gets for its copper? He is only concerned with the price obtained by the particular company that employs him. It may be objected that an interval must elapse between the purchase of custom ore or of miner's labor and the marketing of the copper sold by the one or mined by the other, but that is easily adjusted: pay a nominal price on settlement, and adjust the balance at the end of a specific period. The price at which copper is sold by a given individual or company can be ascertained definitely; the average price at which a variable number of producers sell varying quantities of copper cannot be determined by anybody.

The Wilmington Decision on Flotation—I

Text of Opinion by Judge Bradford in the U. S. District Court

The bill in this suit was brought by the Minerals Separation, Limited, a corporation of Great Britain, against the Miami Copper Company, a corporation of Delaware, charging infringement of three United States process patents relating to ore concentration, owned by the plaintiff, namely, No. 835,120, of November 6, 1906, to H. L. Sulman, H. F. Kirkpatrick-Picard, and J. Ballot, No. 962,678, of June 28, 1910, to H. L. Sulman, H. H. Greenway, and A. H. Higgins, and No. 1,099,699, of June 9, 1914, to H. H. Greenway, assignor to the plaintiff.

Under the processes shown in the three patents a signal advance has been made in the art of ore concentration in point of simplicity, economy and efficiency, and in their practice large commercial success has been realized. * * * Without pausing at this point to consider other processes of ore concentration disclosed in the prior art, hereinafter discussed, an important and, indeed, vital difference between water or gravity concentration under such processes as those above referred to, on the one hand, and concentration under the processes of the patents in suit, is that while in the former the metallic particles after being separated from the gangue in the ore pulp sank to the bottom, in the latter the metallic particles coated with an extremely thin film of oil, become attached to air-bubbles in the ore pulp, and the bubbles with the attached metallic particles rise to the surface, forming a mineral froth of such coherency and permanency as to afford full opportunity for its removal from the surface for further treatment of the metallic particles. The ore pulp in the process of each and every of the three patents in suit consists of a mixture of water and crushed or pulverized mineral ore, together with one or more other ingredients. In each the agitation of the pulp coupled with the introduction of air into it develops and distributes throughout the mixture small bubbles of air which attach themselves to the metallic particles, to the exclusion of gangue, and rise with them and form a metallic air froth on the surface, readily removable therefrom, the gangue particles sinking to the bottom and being disposed of as refuse.

* * * * *

The charge of infringement of patent No. 835,120 is restricted to claims 1, 9, and 12, as follows:

"1. The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter, (amounting to a fraction of one per cent on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation."

"9. The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, agitating the mixture to form a froth, and separating the froth."

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of one per cent of oil on the ore, agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture."

The first patent in suit is for what is known as an air flotation process, in which, owing to the use of a frothing agent in conjunction with such agitation of the ore pulp as will distribute the metallic particles of the ore throughout the mixture and produce bubbles of air and bring them in contact in the mixture with the metallic particles so distributed, the bubbles will become attached to such metallic particles, carrying them separate from the particles of gangue up through the surface of the mixture where they can readily be collected by skimming, overflow, or the use of other well known devices. In this process the frothing agent consists of an oil or other immiscible substance or material of an oily nature, and the bubbles and metallic particles become attached to each other through affinity between the bubbles and the metallic particles enhanced by the coating of the latter with an extremely thin film of oil. The old water processes of ore concentration were in some features gravely objectionable. Under those processes it was desirable to avoid very fine grinding of the ore as being calculated to cause the fine particles containing metal constituting the slimes to escape with gangue particles and be lost, such fine metallic particles, as before stated, not sinking so readily and quickly as those which were larger. In those processes there were two things to be avoided; first, the crushing or grinding of the ore to such a degree of fineness as to lead to the loss of metallic particles through their escape with gangue particles, and secondly, too coarse a crushing or grinding whereby particles of ore containing both metal and gangue might, with the gangue preponderating, too readily be carried to the surface and lost with the other gangue particles. The defendant admits in its brief that the air bubbles collect the metallic particles, and the oil or other modifying agent in the mixture gives permanency to the mineral froth; that the attraction of the air bubbles for the metallic sulphide particles leads to the separation of those particles from the gangue; that in the absence of oil or other modifying agent in the pulp, facilitating the formation of air or

other gas bubbles, no process of ore concentration employing such bubbles is possible; that air flotation may be brought about (1) by introduction of air at the bottom of the mixture or sub-aeration; (2) by beating air into the mixture or supra-aeration; (3) by generation of gas or liberation of air in the mixture. But there is an accentuated difference of opinion between the parties on the point of preferential affinity of oil for metallic particles as compared with gangue. The defendant in its brief states that "in ore flotation processes the oil or other modifying agent does not have any more attraction for the metallic particles than for the gangue." This position, however, is in conflict with evidence on the part of the defendant, with the evidence on the part of the plaintiff, with the documents of the art, and with the result of the physical demonstrations made by both parties in open court.

One of the principal questions in the case is whether patentable invention was involved in the discovery that the minute proportion of 0.1% of oil to the ore was sufficient for commercially successful operations in ore concentration. On this question I had some doubt during the presentation of the case. But that doubt has since been removed. Sulman, Picard, and Ballot had for more than two years prior to March, 1905, been interested in conducting ore concentration under what was known as the 'Cattermole process,' and had been seeking to improve the same in such manner as to render it more efficient and less expensive. There were a number of patents relating to this process, using the term in a general sense, among which were No. 763,259 of June 21, 1904, No. 763,260 of June 21, 1904, and No. 777,273 of December 13, 1904, all to A. E. Cattermole. In the process of each of these patents metalliferous granules are formed and separated from the gangue and fall to the bottom, while the gangue is carried up and away.

Shortly before March, 1905, Sulman, Picard, and Ballot instructed A. Howard Higgins, one of the plaintiff's experts, to investigate by experiments, certain points in their bearing upon the Cattermole process of granulation. They were as follows:

- "(1) Influence of acidity on granulation.
- "(2) Influence of temperature on granulation.
- "(3) Influence of speed of Gabbett agitation on granulation.
- "(4) Influence of ratio of ore to liquor on granulation.
- "(5) Influence of metallic salts on granulation.
- "(6) Influence of the size of particles and of the influence of slimes on granulation.
- "(7) Influence of the amount of oil on granulation."

And the above points were to be determined on "(a) oleic acid, (b) residuum oils." In consequence of his investigations Higgins made a report March 16, 1905, on granulation as affected by the percentage of oil used, in which he said:

"The effect of diminishing the percentage of oleic acid is to alter the type of oiling; the higher percentages pro-

ducing granules, and the lower ones froth. 6% of the oleic acid on the mineral is sufficient to form good granules without much froth. This froth consists of insufficiently oiled mineral mixed with large quantities of air. As this percentage of oleic acid is decreased, the time for clean up of the sands is increased and more froth is formed. 0.62% oleic acid on the mineral is insufficient to form any granules and nearly the whole of the mineral comes to the surface, on stopping the cone, as froth. 0.2% acts in the same manner, leaving the coarse sands with rather more mineral in them. (This is 0.1% on Broken Hill ore.) In all cases the oil has been measured in cubic centimetres and the percentage calculated as though they weighed grams, but as the specific gravity of the oleic acid is less than unity this is not the case, and all percentages will be lower than those actually given."

There was, I think, patentable invention in the discovery thus made in March, 1905. Prior to that time there had been no suggestion in the art that the proportion of 0.1% of oil to ore or of any other fraction of 1% of oil to ore would or might result in successful concentration. Further, the result reached was an utter surprise. Experiments were conducted with reference to the Cattermole process, and all of the Cattermole patents required the formation and sinking of granules containing the metallic particles, and not their flotation. The teaching of that process was that the metallic particles should go to the bottom and that of the process of the first patent in suit that they should go to the top. But while the ascertainment that such a minute proportion of oil would effect a successful concentration of ore through a flotation process was a discovery, it was nevertheless of such a character, viewed with respect to the circumstances under which it was made, as to involve invention and confer patentability. The statutes provide for patenting new and useful inventions and discoveries, but a bare discovery unaccompanied by the exercise of any invention in reaching it or utilizing or reducing it to practice would not justify or support a monopoly in the discovery. In the present case, however, the facts disclose not a bare discovery, but a discovery coupled with invention in usefully applying it. In such cases patents properly may be granted. The defendant lays much stress upon the proposition that the reduction of the amount of oil in the process for the concentration of ore did not and could not involve patentable invention, but only an ascertainment of the proper degree in which oil should be used, which was readily discoverable by any one competent to conduct or superintend a process of ore concentration; and further, that motives of economy would naturally have suggested a reduction in the quantity of oil to the extent of its excess over what was necessary for the accomplishment of the purposes of the process. But if such a reduction was obvious, why is it that it was never made prior to the discovery in question? The fact that economy required the use of the least quantity of oil sufficient for the conduct of the process affords cogent evidence that the feasibility of effecting a reduction

was not obvious, but properly the subject of patentable invention. No one today understands how the use of only 0.1% of oil operates to secure the mineral froth of the first patent in suit. This is testified to by experts and is admitted on both sides. If the principle of operation of the discovery is insolvable to the human mind today it could not have been predicted or anticipated by the human mind in March, 1905. The fact that the underlying principle of the process was not understood by no means negatives patentability. * * * * *

This case is unlike those in which the discovery of the use of an element in a process in the degree insuring the best results is a matter within the competency of those skilled in the art, but, on the contrary, is one where clearly there was patentable invention or discovery in ascertaining the degree. The experiments made with respect to the Cattermole process were initiated with a view to its improvement and the securing of granulation of a higher efficiency. The prosecution of the experiments relating to a sinking and not a flotation process would naturally tend to divert the mind from the contemplation of any process of the latter character. Pertinent to this point is the following testimony of Mr. Higgins:

"I do not remember anything being said about the quantity of oil, except the quantity used was always adjusted to give granulation.

"44Q. In adjusting the oil to give the best granulation, I presume you experimented with different quantities of oil?

"A. Yes, there may have been different quantities, but whenever the granulation became imperfect by reason of the drop in the quantity of oil, the oil was naturally increased."

I perceive no escape from the conclusion that the discovery was patentable. To decrease the amount of oil used in an old process, so long as the characteristic mode of operation and result of such process are preserved, even though in less degree, does not as a general rule involve invention. But when the old mode of operation and its result through a decrease in the amount of oil disappear and a new and different result is disclosed the change ceases to be one of mere degree, and may support a patent monopoly in favor of one whose inventive genius or research has discovered the process. The patentability of the process of the first patent in suit resides in the use of only the minute quantity of oil contemplated by the patent. The reduction of the oil to this quantity effected a change, not merely in degree, but in the "type of oiling," leading to results which cannot be accounted for on the assumption that a mere change in degree as distinguished from patentable discovery was involved.

The defendant contends that a substantial increase in the amount of oil used will not affect the nature or efficiency of the process of separation, but will only add to the cost by carrying it on with an unnecessary amount of oil. But this position is in conflict with the decided weight of the evidence and with the showing of the experiments conducted by Higgins at and immediately

prior to the time of the discovery. It is satisfactorily proven that the process of the first patent in suit, depending upon the selective affinity of the air-bubbles in the mixture for oil-coated metallic particles, that affinity is strongest when the film of oil surrounding the metallic particles is so thin as to be imperceptible to the senses, and that with any substantial increase in the quantity of oil on the metallic particles the character of the process is changed and its efficiency diminished for some reason as yet unrevealed.

A great advance in the art of ore concentration has resulted from the process of the first patent in suit in the efficient recovery of slimes. With the use of that process ore may be so finely ground as to insure the thorough separation of the metallic particles and gangue, and great savings effected. The profit so saved in a single year from the output of the principal porphyry copper mines, including the defendant's, has been estimated by one of the expert witnesses as more than \$17,000,000. In *Moore Filter Co. v. Tonopah-Belmont Development Co.*, 201 Fed. 532, 540, the circuit court of appeals for the third circuit, in dealing with an ore concentration case, said:

"When, therefore, Moore disclosed a process by which such recovery was made enormously profitable, and by which he turned a dump heap, which, under all known processes, machines, and laboratory methods, was worthless, into profitable ore, we are constrained to give little weight to the suggestion that his process was either anticipated, a mere advance incident to the art, or involved no invention."

The defendant sets up as part of the prior art to negative invention United States patent No. 689,070 of December 17, 1901, to A. S. Elmore. This patent was for an "Improvement in separating mineral substances by the selective action of oil," and contains but one claim as follows:

"The process for separating metallic and rocky constituents of ore which consists in mixing pulverized ore with water and mixing the ore and water with oil in the presence of an acid, allowing the mixture to rest whereby the oil having the metallic substances entrapped in it floats at the top of the mixture, and separating the metallic constituents from the oil, substantially as described."

In the description it is stated:

"The selective action of oil has been utilized for separating metallic substances from earthy or rocky constituents of ores. This has generally been done by pulverizing the ore and suspending it in a considerable quantity of water, so as to make a freely-flowing pulp, then mingling with it oil, preferably heavy oil, such as is obtained from petroleum after some of the lighter oils have been distilled from it. When the mixture rests, the oil, with most of the metallic substances entrapped in it, floats at the top and is separated from the rocky or earthy matters, which are run off with the water as tailings. The oil is afterward separated from the metallic substances, usually by centrifugal action."

The patent nowhere states the amount of oil which is

to be used or the ratio between the weight of the oil and the weight of the ore or its metallic content. It, however, clearly appears from the evidence that the process was what has been termed a "bulk oil process," employing from one to two and a half or three tons of oil to each ton of the pulverized ore to be treated. By reason of the large amount of oil used and the loss of a considerable proportion of it in operation the process was expensive and unsatisfactory. There was but a small recovery from the slimes, probably for the reason that the extremely minute metallic particles contained in them did not yield to centrifugal action employed in the separation as readily as the larger particles.

* * * * *

The defendant also relies upon the patent No. 348,157 of August 24, 1886, to Carrie J. Everson, for an "Improvement in processes for concentrating ores," as part of the prior art. The patent specifies two methods of conducting the process. It is admitted that the first method requires oil amounting to 5% on the weight of the ore. With respect to the second method it is stated in the patent description:

"I have found three fluid drams of oil abundant for properly moistening two ounces of heavy ore, or in the ratio of about a barrel of oil to the ton of ore, the amount being, of course, variable with the relative bulkiness of the ore."

Dr. Liebmann testifies that the oil used in the process was 16.5% of the weight of the ore, and Dr. Sadtler says that the amount of oil so used was from 16% to 17% of the weight of the ore. The Everson process has never been used commercially and Dr. Liebmann states that it could not be so used; that "it is not a process for large scale operations"; but that there was a possibility of its application to gold and silver in small quantities. Dr. Sadtler expresses no opinion upon the applicability of the Everson process to the concentration of ore on a commercial scale, and states, in substance, that he had never practiced the Everson process in either of the methods disclosed in the description of the patent. The defendant argues that in the Everson process the concentrate "could not possibly float by the bulk oil flotation principle, for the simple reason that the amount of oil was insufficient for that purpose"; that with the use of only 17% of oil no bulk oil flotation is possible; and that the process "could not have resulted in surface tension flotation, skin flotation, or film flotation, so-called, for the simple reason that the conditions for that form of flotation were absolutely wanting." But this contention fails, I think, to negative patentable invention in the process of the first patent in suit. I am not satisfied by any experiment or demonstration made in the case that the process described in the Everson patent would produce the economical and efficient concentration secured by the process of the first patent in suit. Certainly, were there nothing else, a reduction in the quantity of oil from 17% or even 5% to a fraction of 1% on the weight of the ore, under circumstances similar to those attending the discovery of the sufficiency of that

minute proportion for successful metallurgical operations would be sufficient to confer patentability.

* * * * *

Much stress is laid by the defendant upon an article in the *California Journal of Technology* of November, 1903. This article was prepared by three young men, students in the class of 1903 in the mining department of the University of California, and is entitled 'Experiments on the Elmore process of ore concentration.' This article is suggestive, but cannot, I think, be justly treated as negating the exercise of invention with respect to the process of the first patent in suit. The experiments were laboratory tests and did not disclose or suggest the idea that such a minute quantity of oil as one-tenth of one per cent, or any fraction of one per cent, on the weight of the ore could be efficiently and successfully employed in ore concentration. There were a number of tests with respect to the concentration of molybdenite ore with percentages of oil to ore running from 2.1% to more than 100%, with the result that the highest extraction of molybdenite sulphide was obtained by the use of 8.9% of oil; the extraction in that case being 75% as against an extraction of 43.5% obtained by the use of 2.1% of oil. The teaching of these tests was that 2.1% of oil, was less efficient than the use of 8.9%, and the article as a whole, far from suggesting the possibility of the use of only a fraction of one per cent of oil points to an opposite conclusion.

The defendant contends there is nothing new in the employment of only a fraction of one per cent of oil relative to the weight of the ore in the process of the first patent in suit, for the reason that, as alleged, an equally small proportion of oil was used in the process of the Cattermole Patent No. 777,273, mentioned in the first patent in suit. The Cattermole patent mentions from four to six per cent in weight of oil to the weight of the metalliferous mineral present in the ore, and consequently, under the Cattermole process the amount of oil to be used depends upon the weight of the metalliferous mineral, and not upon the weight of the entire ore, and there is evidence to the effect that the larger part of the copper ores mined and concentrated in this country contain about two per cent of copper. Hence the argument is made by the defendant that the weight of oil employed in the Cattermole process is only from 0.8 to 0.12% of the weight of the copper contained in the ore, and that any proportion of oil less than one per cent of the weight of the ore comes within the quantity mentioned in the first patent in suit, namely, "a fraction of one per cent on the ore." This contention ignores the following statement in the description of the Cattermole patent now considered:

"In certain cases, as where but little mineral is present in the ore, to increase the nucleating or granulating factor pulverized mineral matter obtained in a previous operation or other matter having an affinity for oil from a different source may be introduced into the ore, or a portion of already granulated and separated mineral

matter may be returned to maintain the necessary amount of mineral in the ore under treatment."

It is evident that the weight of "pulverized mineral matter" introduced to "maintain the necessary amount of mineral in the ore under treatment" is, for the purpose of determining the necessary amount of oil, to be added to "the weight of metalliferous mineral matter present in the ore." Such must be the meaning of the patent or it is insensible. And this accords with the requirement in the seventh claim of "adding particles of material having an affinity for oil to assist in the formation of granules of oil-coated particles." The defendant has made no demonstration, as might have been done, of the amount of oil required by the Cattermole process in its application to lean copper ores, but indulges in speculation and conjecture on that point. The defendant contends that in the Cattermole process of the above patent there were necessarily two degrees of agitation of the mixture; the first being violent and the second gentle. On the assumption that two degrees of agitation were required in the Cattermole process; first, violent agitation of the mixture in order to bring the oil into intimate contact with the mineral particles; and, secondly, the subjection of the mixture to a slower or rolling form of agitation to cause the agglomeration of the oiled metalliferous particles and the formation of granules, it by no means follows that with the omission of the second step the mineral froth of the process of the first patent in suit would have been formed, had there been in the mixture oil in excess of the proportions contemplated by that patent. And if it be further assumed that the mixture containing oil and other elements in Cattermole proportions can first be violently agitated so as to produce a froth and then slowly agitated so as to produce granules, and again violently agitated so as to destroy the granules and restore the froth, and so on by alternation, and that, the mixture remaining the same, the production of froth on the one hand, or granules on the other, is simply a matter of manipulation, it is not to be inferred that the froth so formed with Cattermole proportions of oil would be the froth of the first patent in suit. Dr. Liebmann, for the purpose of distinguishing between the Cattermole process and that of the first patent in suit, during the trial conducted two experiments, identical in their nature, save that in one a larger amount of oil was used than in the other. In the former case granules were formed which sank; and in the latter a mineral froth was formed, the agitation and other factors being the same. 3.6% of oil and 0.1% of oil were respectively used in the two experiments. Both were performed in the same apparatus with similar materials and manipulation. These experiments served to show that the variation in the amount of oil used, other things being equal, may result in the formation of the mineral froth of the first patent in suit, or in the formation and sinking of the granules of the Cattermole process. In this connection it is to be observed that the Cattermole patent in its descriptive portion states:

"With certain ores it may be preferable to use in some stages of the process a rolling form of agitation,

as in cylinders or barrels, to obtain good granulation of the mineral."

The description of the patent nowhere specifies that its process is necessarily dependent upon two degrees of agitation, one violent and the other slow or rolling, and in none of the seven claims of the patent, with the exception of the fifth, in such a requirement mentioned or suggested. In that claim only is there a provision for "further agitating the mass to increase the size of the granules," and even in that claim there is no suggestion of a difference in degree between such further agitation and the agitation which has preceded it. For the foregoing reasons I think that the contention of the defendant that the quantity or proportion of oil used in the Cattermole process was not materially in excess of that used in the process of the first patent in suit, and that, not a difference in the quantity of oil, but a resort to two degrees of agitation was essential to the formation of Cattermole granules, cannot be sustained.

The defendant also relies upon two patents granted to Alcide Froment; one of them being British patent to Henry Harris Lake, communicated by Alcide Froment, No. 12,778 of 1902, and the other an Italian patent to Froment, No. 63,723, the specification of which is dated May 20, 1902. The Froment Italian patent was in the French language, and there is an English translation in evidence. The process covered by this patent was entitled "A process for enriching sulphide and copper ores, lead ore and blende by gases combined with fatty bodies." The inventor stated as phenomena which had been studied by him and served as the basis of the patented process the following:

"1. When the natural sulphides reduced to fine powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of water.

"2. This tendency is simply retarded by the specific weight, and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

"3. If a gas of any kind is generated in this mass, the bubbles of this gas become covered with an envelope of sulphide and thus rise readily to the surface of the liquid where they form a kind of metallic magma.

"4. The formation of these metallic spherules is singularly active, if the gas is in a nascent state."

(To be Continued)

OPERATING REVENUE of United States steam railways during the year ended June 30, 1916, totaled \$3,396,808,234, an increase of \$508,359,921. Operation cost \$2,220,004,233. These roads cover approximately 230,000 miles, or 90% of the steam mileage in the country.

TIN-PLATE EXPORTS of the United States exceed any previous records, and in the first half of 1916 totaled 122,839 tons, or 20,473 tons per month. In the year ended June 30, 1915, the rate was only 6667 tons, and in the previous year 3939 tons per month.

FERRO-MANGANESE is quoted at \$170 per ton.

Flotation in the Clifton-Morenci District, Arizona

By David Cols

*At the time flotation appeared upon the metallurgical horizon of Arizona, the writer, under the direction of Dr. L. D. Ricketts, was engaged in re-modeling and enlarging the No. 6 concentration plant of the Arizona Copper Co. at Morenci, and the work had been in progress nearly a year before the Inspiration experiments with flotation disclosed the revolution in concentration that was impending.

The simplified flow-sheet for the Morenci plant had been based upon the removal of the freed metal in a minimum number of stages by treatment upon tables equipped with Butchart riffles, the latter being adapted to accomplish both classification of feed and removal of the metal at one operation.

The scheme of treatment for the slime was based upon the fact that after copper sulphides, such as chalcocite and chalcopyrite, are reduced to a certain state of comminution they are definitely beyond the reach of separation upon any of the concentrating devices then known.

By using drag-belt classifiers (which served as conveyors as well as separators), the overflow would be of the usual 'slime' class. Experiment had shown that when these drag-belt overflows were properly diluted (that is, to about 5 to 7% solid in the feed under treatment) the fine sand, and especially the fine but still granular sulphide particles, would, if given a short distance to fall, settle quickly in prime condition to yield an excellent recovery on vanners; further, the fine non-separable final overflow might be discharged direct to tailing, thus conserving space.

For reasons that are obvious, this kind of feed preparation for the slime could not be accomplished successfully in any form of pointed box or spitzkasten, therefore a further elaboration of the drag-belt idea was worked out as the best method for accomplishing the separation. This machine was known as a colloid separator and is shown in Fig. 1 and 2. It works on the premise that nearly all of what may be called ponderable material in the thinned pulp, falling but two inches, will lodge upon the belts and be removed, while the flocculent slime will remain in suspension and go away with the overflow. In this way a feed is prepared for the vanners containing a maximum amount of the very fine but granular sulphides and a minimum of colloidal material; at the same time the drag-belt overflow contains a minimum of sulphide particles and a maximum of flocculent slime. This final overflow was found to be

approximately two-thirds of the total tonnage handled by the belts, so that treatment upon vanners was devoid of beneficial results. The copper escaping in this overflow was in the form of fine chalcocite, bornite with a little pyrite and chalcopyrite, together with oxidized, and water-soluble, copper salts. Taken together, these gave the overflow a copper tenor of from 1 to 1.3%, thereby accounting for the larger part of the tailing loss. However, this overflow, with its ultra-fine and otherwise handicapped copper-bearing material, was practically beyond the reach of any concentrating machine at that time known, and could therefore go to tailing. A Dorr thickener 130 ft. diam., the first one of such large size, was devised to recover the water from this overflow before it was allowed to go to waste. See cover of this issue.

By this plan, the treatable portion of the slime could be handled by the complement of vanners already installed in the mill. This arrangement, in conjunction with the saving in floor-space, resulting from the introduction of the Butchart riffle, made it easily possible to double the capacity of the plant under practically the original roof. While it did not promise to recover a larger percentage than usual of the truly slined copper, it did promise to give the best possible results in one-half the space.

By the time this flow-sheet had been put into practical operation, the Inspiration experiments were attracting wide-spread attention and flotation was beginning to be taken seriously as a process for the concentration of copper ores. It was, however, still regarded as an auxiliary process and was thought to be inapplicable to ores carrying an excess of tale or clay, like the Clifton-Morenci ores. Some experiments with the Elmore process on these ores in former years had been unsuccessful and laboratory work that we did later on a small scale seemed to corroborate this view. Space was reserved, however, in the mill-building for the installation of flotation equipment in case further development should prove it desirable.

Meanwhile, the Inspiration company had built the 600-ton pilot mill, in which the new process was rapidly graduating from an auxiliary into the main method of separation, in the manner so fully described by Dr. Rudolf Cahl.¹ Starting with semi-mysterious compounds, the Inspiration staff soon found that simple flotation reagents were equally efficacious. Through the

*Abstract of paper read before the Arizona meeting of the American Institute of Mining Engineers, in September 1916.

¹See also 'The Flotation Process at Inspiration,' Another paper read at the same meeting of the Institute. We published extracts from our issue of September 23 and 30, 1916.

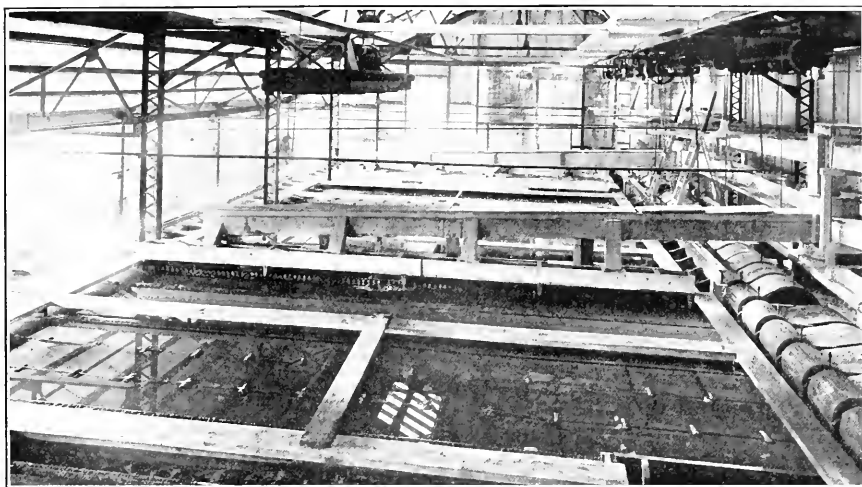


FIG. 1. DRAG-BELT SEPARATORS IN MILL OF ARIZONA COPPER CO.

kindness of Mr. Charles E. Mills, the manager, I secured a drum of cresylic acid and some pine-oil with which to try a few experiments at Morenci.

The tailing from the No. 6 concentrator was at that time discharged into Morenci canyon and cascaded for about one mile before being taken into a flume to be carried to the impounding dams. The creek-bed was rough and steep, inducing great agitation of the pulp and resulting in the production of large amounts of white froth, which floated down the stream. This froth ear-

ried no concentrations of copper minerals, but I thought it might be possible to change its character and produce a mineral froth by the use of flotation reagents introduced where the tailing left the mill, and thus possibly secure from the natural situation some benefit at little cost.

A small can of the cresylic acid was arranged to drip into the tailing-launders at a point where the tailing made its first plunge into the creek-bed. The results were instantaneous. Black froth began to collect in



FIG. 2. ANOTHER VIEW OF DRAG-BELT SEPARATORS.

eddies and float down-stream for a few yards to a second plunge where we were greatly surprised to find that it became white again on account of the instant dropping of the metallic load. Feeding the reagent into the stream immediately above the second plunge would not cause a mineral-froth to rise as in the first plunge, and the failure was finally debited to a town sewer which was discharging under the surface into the creek between the two pools; the sewage effectively killed the metal-carrying capacity of the froth.

Cresylic acid was then added to the feed of a re-grinding Hardinge mill, which was discharging into a long drag-belt classifier. The results were again most encour-

bends. The pipes were drilled full of small holes and were wrapped with cotton blanket tied with spirally wound wire. This tube-grate air-filter was put into the drag-belt trough as deeply as possible, without touching the belt. Coarse sand could pass through between the grates and be removed by the belt underneath. The pipes were supplied with compressed air for the purpose of creating additional froth, and it was found that the product, without further treatment, assayed 40% copper, 1.14% of which was oxidized, and that it carried but 20.4% insoluble.

Plans for a small frothing-machine of the mechanical-agitation type were made immediately, and on July 20

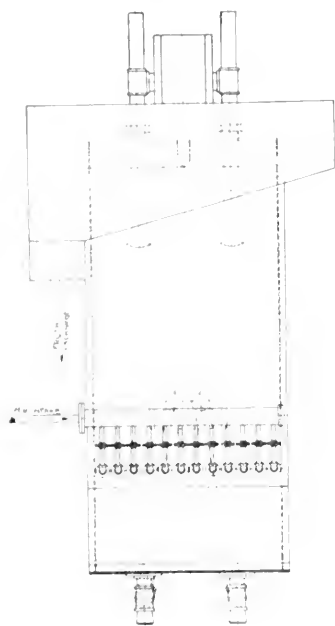
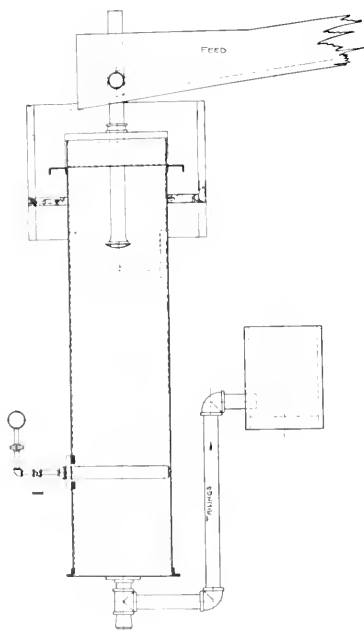


FIG. 1. SAMPLE TUBE-GRATE CELL



aging; black mineral froth began immediately to appear and to collect in large volume upon the relatively still water in the drag-belt trough. This rough froth-concentrate was found to assay over 40% copper; the product contained 35% insoluble, mostly in the form of coarse sand, mechanically suspended in the froth and easily separated by screening. It was found that 1% of the copper in the froth concentrate was in oxidized form, 22% of the concentrate was too coarse to pass a 100 mesh screen, and this portion carried only 0.87% copper, while the *minus* 100 mesh material carried 16% copper, 1.32% of which was oxidized, and but 16% of insoluble. The high grade of the froth concentrate was astonishing, showing that chalcocite and bornite predominated in it.

A few days later I made a bank of tube-grates, consisting of a parallel 1 in. pipes made up with return

the apparatus was tried with the colloid separator-line as feed, with the following remarkable result: Feed, 2.23% copper, of which 0.62% was oxidized; the concentrate assayed 20.4% copper, of which 1.18% was oxidized; the tailing carried 0.52% copper, of which 0.38% was oxidized, leaving only 0.11% sulphide copper as the rejection of the machine. This was an extraction of more than 70% of the total copper, and more than 92% of the available sulphide copper. This showed clearly that much could be expected in the application of the new process to Morenci ores.

The Canadian Consolidated Copper Co., in Sonora, Mexico, had been experimenting with the use of some Flinn-Towne pneumatic flotation units in its concentrating department. The plant had been shut-down on account of revolutionary troubles, and arrangements were made by Dr. Ricketts for the removal of one of these

SCREEN ANALYSIS										G-B MACHINE									
MACHINE TAILS					MACHINE CONCENTRATES					VANNER TAILS					VANNER CONCENTRATES				
SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total
WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
1.1	11.077	0.85	1.41	2.26	1.4	1.0	0.8	2.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
3.6	43.0	2.97	5.01	7.98	4.5	5.3	4.0	8.1	12.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
1.0	10.0	0.8	1.4	2.2	1.0	1.0	0.8	2.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
4.7	37.0	3.0	5.4	8.4	5.5	5.3	4.0	8.1	12.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
1.2	12.0	0.9	1.5	2.4	1.2	1.2	0.9	2.1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6.9	55.0	4.67	8.41	13.08	7.5	7.5	5.6	11.1	18.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
24.1	100.0	17.9	31.8	49.7	24.1	24.1	18.0	36.0	58.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Total	60.0	46.25	80.25	126.5	60.0	60.0	46.0	92.0	148.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Check	46.1	34.2	58.4	92.7	46.0	46.0	34.0	68.0	108.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0

SCREEN ANALYSIS										CALLOW MACHINE									
MACHINE TAILS					MACHINE CONCENTRATES					VANNER TAILS					VANNER CONCENTRATES				
SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total
WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
2.5	25.0	1.9	3.3	5.2	3.0	3.0	2.4	4.8	7.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
4.3	43.0	3.3	5.3	8.6	4.0	4.0	3.2	6.4	9.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
1.2	12.0	0.9	1.5	2.4	1.2	1.2	0.9	1.8	2.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
6.9	55.0	4.67	8.41	13.08	7.5	7.5	5.6	11.1	18.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
24.1	100.0	17.9	31.8	49.7	24.1	24.1	18.0	36.0	58.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Total	60.0	46.25	80.25	126.5	60.0	60.0	46.0	92.0	148.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Check	46.1	34.2	58.4	92.7	46.0	46.0	34.0	68.0	108.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0

SCREEN ANALYSIS										G-B MACHINE									
MACHINE TAILS					MACHINE CONCENTRATES					VANNER TAILS					VANNER CONCENTRATES				
SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total
WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
2.5	25.0	1.9	3.3	5.2	3.0	3.0	2.4	4.8	7.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
4.3	43.0	3.3	5.3	8.6	4.0	4.0	3.2	6.4	9.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
1.2	12.0	0.9	1.5	2.4	1.2	1.2	0.9	1.8	2.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
6.9	55.0	4.67	8.41	13.08	7.5	7.5	5.6	11.1	18.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
24.1	100.0	17.9	31.8	49.7	24.1	24.1	18.0	36.0	58.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Total	60.0	46.25	80.25	126.5	60.0	60.0	46.0	92.0	148.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Check	46.1	34.2	58.4	92.7	46.0	46.0	34.0	68.0	108.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0

SCREEN ANALYSIS										G-B MACHINE									
MACHINE TAILS					MACHINE CONCENTRATES					VANNER TAILS					VANNER CONCENTRATES				
SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total	SOLIDS	ASSAY	% Cu	% Ag	% Total
WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
2.5	25.0	1.9	3.3	5.2	3.0	3.0	2.4	4.8	7.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0.8	8.0	0.6	1.0	1.6	1.0	1.0	0.8	1.6	2.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
4.3	43.0	3.3	5.3	8.6	4.0	4.0	3.2	6.4	9.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
1.2	12.0	0.9	1.5	2.4	1.2	1.2	0.9	1.8	2.7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
6.9	55.0	4.67	8.41	13.08	7.5	7.5	5.6	11.1	18.7	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
24.1	100.0	17.9	31.8	49.7	24.1	24.1	18.0	36.0	58.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Total	60.0	46.25	80.25	126.5	60.0	60.0	46.0	92.0	148.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Check	46.1	34.2	58.4	92.7	46.0	46.0	34.0	68.0	108.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0

TABLE 1. SCREEN ANALYSES. REDUCED FACSIMILE OF AUTHOR'S TABULATIONS.

units to the No. 6 concentrator at Morenci. The apparatus was installed under the direction of the Flinn-Towne people in the space reserved for flotation and was operated for several weeks with gratifying results as to recovery. These experiments demonstrated clearly that the flotation process would be suited to the saving of slimed copper sulphide in the Morenci ores. But the Flinn-Towne units were not of size suitable for use in the equipment of a large plant, or for the handling of large tonnages, except by using a great number of them. It was thought that their capacity could not be enlarged to advantage because of the difficulty with the air-emitting medium used, which was in circular-disk form with central discharge. These disks could not be made larger in diameter without increasing the difficulty coming from 'blinding' of the air-emitting surfaces through the lodging of coarse particles upon them, and from the formation of vortices by the larger volume discharged through the single opening in the centre, entraining froth with the reject.

The tube-grate idea previously tried in the drag-belt tank seemed to be a better way to admit air, because nothing could lodge upon the air-emitting elements to blind them, and constriction of the passage for the pulp and water would be avoided. This tube-grate idea therefore formed a basis on which to design units of large capacity for practical milling and especially to obviate the difficulty of limited space in the No. 6 concentrator. Accordingly, a tube-grate cell was installed in January 1915. This simple cell is shown in Fig. 4. It was used for some time to demonstrate the tube-grate idea and served as a 'cleaner' in the subsequent work done with a full-size machine.

The demonstration of the new

tube-grate cell was such a success that a three-stage machine, to have a capacity of 400 tons per day, called the C-B machine, was designed and made. Another one of the same kind and size was made concurrently for the Inspiration company, and both of them were started in operation early in March. The Inspiration machine, which is illustrated in Dr. Gahl's paper, gave good results, proving the design to be substantially correct. The Morenci machine was working in corrosive water, which formed a rust on the steel tubes and gradually closed the openings. The air-supply was found to be contaminated with grease and oil from the blower-bearing-

sulphide copper present in the feed, with an average for the period of 65%.

The blower was an old one borrowed from the mining department, where it had been used for ventilation. It was designed for not more than $3\frac{1}{2}$ -lb. pressure, and the developing of 6-lb. pressure deflected the shafts and caused the impellers to rub upon the sides of the machine, which had to be water-jacketed to keep down the heat developed. It was much larger than necessary, and a great excess of air was blown off from open valves. Therefore, no record of the amount of air used or power required could be made.

In spite of these minor difficulties it was proved: That flotation could be applied to these ores with great advantage; that the copper in the mill-tailing could be reduced to 0.50% (of which 0.25 to 0.30% was oxidized and beyond the reach even of

flotation); that this result could be improved by finer grinding in the Hardinge mills; that the same simple reagents used elsewhere would apply. Further, a new type of pneumatic flotation machine, well adapted to

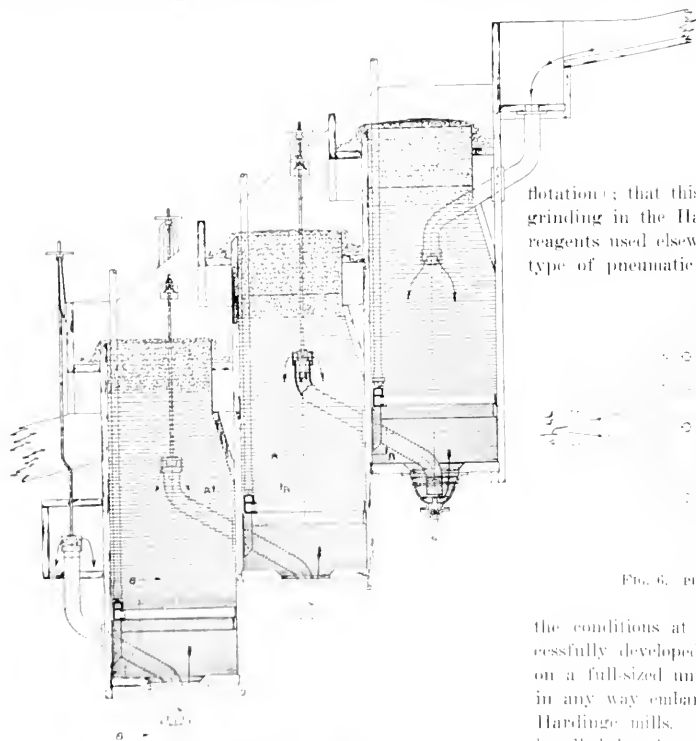


FIG. 5. LONGITUDINAL SECTION OF C-B FLOTATION MACHINE. THREE CELLS IN SERIES.

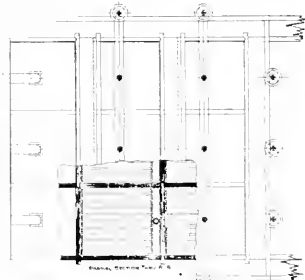


FIG. 6. PLAN OF C-B FLOTATION MACHINE.

ings, muddy water entrained in the air, etc., which closed the pores of the filter from the inside. Some delay was experienced in overcoming these difficulties.

The C-B machine at Morenci made large volumes of rich froth and had become immediately profitable by reason of its being able to handle a large tonnage and save copper that would be otherwise beyond the reach of concentration. It was therefore kept in operation, even though working under the handicap of partly clogged tubes, blower troubles, etc. The daily tonnage handled during the month of April 1915 was from 125 to 390 tons per day, with an average of 269. The recovery made by the machine was from 45 to 79% of the

the conditions at No. 6 concentrator, had been successfully developed and its performance demonstrated on a full-sized unit. The new machine would not be in any way embarrassed by the oversize coming from Hardinge mills. All of the drag-belt overflow being handled by the colloid separator could go to a few of these new machines where all of the rich slined sulphide copper would be taken out. Or the whole tonnage of re-ground material produced in the Hardinge mills could go directly to the new frother in which the slined copper sulphides would be removed. The thoroughly frothed sand could then be treated on tables and vanners for the removal of the sulphide particles too coarse to be separated by flotation. Since there would then be no embarrassing losses in the slime part of the feed, these machines would work efficiently, and a maximum recovery would ensue.

After it became evident that flotation would apply to Morenci ores and before the value of the tube-grate idea was fully demonstrated, it was decided to install and experiment with a standard Callow flotation unit of

200-ton capacity, consisting of four rougher cells and one cleaner. This equipment was not received until after the full-sized C-B unit of 400-ton daily capacity had been installed.

The Callow equipment was started on May 24, 1915, and competitive operation proceeded for about three months. The recoveries proved to be much alike, although the feed was not identical. The Callow apparatus is not adapted to handle coarse particles of feed or oversize, and had to be protected by a screen or spitzkasten. It will handle about one-half the normal tonnage of the C-B machine, occupying the same floor-space. A summary of the results obtained for the months of May, June, and July 1915, also details showing the work for the month of July, are given in Tables 1 and 2. The performance is shown to be substantially parallel as to quality of work done, but quite different as to quantity handled.

As mentioned before, the consumption of air and power was not determined in the C-B installation because there was no way to take correct measurements. But the experience at Inspiration, where the C-B and Callow systems were also being operated in parallel, showed that the same amounts of air and power were used by each system.

Experience suggested wider launders for froth, larger 'cleaner' capacity, and simplified tube-grate construction of the C-B unit. These ideas are incorporated in

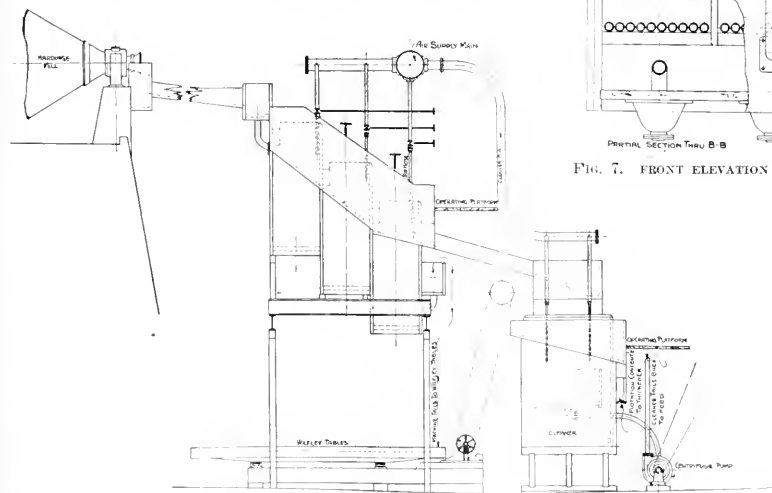


FIG. 8. ARRANGEMENT AT MILL OF CANANEA CONSOLIDATED COPPER CO., CANANEA, MEXICO, USING THE C-B 3-STAGE FLOTATION MACHINE.

the new design shown in Fig. 5, 6, and 7, in which it will be noted that the machine is merely a stationary wooden box suitably arranged to receive air-emitting tubes that are dropped from the top and rest upon ledges at the proper level in the pulp. These air-emitting elements are connected to the air-supply by the use of rubber hose. They can be taken out or put in without cutting off the feed or shutting down the ma-

chine, in case this should be of advantage. An air-pressure of 5 lb. is required. The air-emitting surface in the C-B machine is more than twice the complete cross-sectional area of the frothing compartments, and

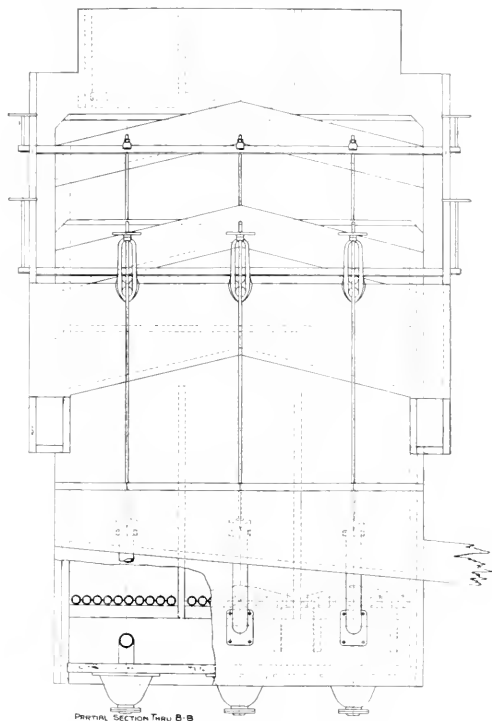


FIG. 7. FRONT ELEVATION OF C-B FLOTATION MACHINE.

even if a ridge of sand should lodge upon the extreme top of the tubes and partly cut off the air-supply, the remaining unobstructed area would still be larger than the whole cross-section.

Fig. 8 shows the improved form with cleaners as arranged in the mill at Cananea, and is typical of the arrangement adopted for the later models. There are eight units, operated under conditions varying greatly as to quality of ores, there being a wide range of iron and copper sulphide conditions and all conditions of oxidation in the ore handled. The operation of the Cananea machines has been repeatedly interrupted by the internal strife in Mexico and no deductions of value are at present available.

Fig. 9 shows an application of the tube-grate idea to

a spitzkasten type of frother. One of these machines was made and installed in No. 6 concentrator at Morene, but was taken out before it was tried. It seems to embody advantages of much promise in a frothing-first flow-sheet and will soon have a trial to determine its value in the simplified concentration of ore that is amenable to flotation.

TABLE 2. COMPARATIVE RESULTS OBTAINED IN OPERATION OF C-B CALLOW FLOTATION MACHINES AT CONCENTRATOR No. 6, ARIZONA COPPER COMPANY.

May 1915		
	C-B,	Callow,
	%	%
Flotation tailing:		
Total copper	0.72	0.81
Oxidized copper	0.38	0.30
Sulphide copper	0.34	0.51
Flotation concentrate:		
Total copper	38.19	24.82
Insoluble	25.00	27.00
Vanner tailing:		
Total copper	0.53	0.46
Oxidized copper	*	0.18
Sulphide	*	0.28
Vanner concentrate:		
Total copper	8.52	8.89
Insoluble	*	30.60
June 1915		
Flotation tailing:		
Total copper	0.71	0.69
Oxidized copper	0.30	0.28
Sulphide copper	0.41	0.41
Flotation concentrate:		
Total copper	35.24	25.41
Insoluble	23.80	26.00
Vanner tailing:		
Total copper	0.41	0.42
Oxidized copper	0.23	0.22
Sulphide copper	0.18	0.20
Vanner concentrate:		
Total copper	9.35	9.51
Insoluble	*	*
July 1915		
Flotation tailing:		
Total copper	0.61	0.66
Oxidized copper	0.24	0.23
Sulphide copper	0.37	0.43
Flotation concentrate:		
Total copper	27.84	24.80
Insoluble	18.80	24.60
Vanner tailing:		
Total copper	0.41	0.37
Oxidized copper	0.25	0.15
Sulphide copper	0.16	0.22
Vanner concentrate:		
Total copper	7.96	6.10
Insolubles	*	*
Table tailing:		
Total copper	0.41	0.15
Oxidized copper	0.24	0.25
Sulphide copper	0.17	0.20
Table concentrate:		
Total copper	8.96	7.81
Insoluble	43.60	*
C-B Callow		
Daily tonnage rate, average for the month of		
July, 1915	479	539

*No assay.

Without protection against blinding of the air emit-

ting media by sand or oversize, the C-B machine handled considerably more than three times the tonnage handled by the Callow in July, and did this without detriment to the metallurgical work.

IN THE WORLD'S HISTORY, the industrial epoch on which we are now well entered, has raised the most complex questions as to social and political relationships the human race has so far had to face. Unfortunately there are kaisers in industry just as there have proved to be in politics. The inevitable result in both cases has been war—in the one case for social and industrial freedom, and in the other for political freedom. Only enlightenment can create the co-operative, constructive spirit. But the enlightenment must be such as discriminates the large from the small, the principle from the detail, wisdom from mere knowledge. When, at last, we acquire wisdom as well as knowledge, we shall see that our industries exist for the benefit of all the people and not of the capitalist mainly; we shall see that the individual welfare can best be taken care of by caring for all; we shall see that capitalist and workmen are as inter-related as the parts of the human body; that neither is servant of the other, but that each is both servant and master; that we cannot injure the one without injuring the other; that we have here one of the highest problems the human mind has set itself to solve; that the best combined wisdom of all will be required to work out the best progressive solution of this greatest of industrial problems; that no solution of a problem of this nature will be final except in principle; that this is only one of those adjustments of human relations which must be continuous with the evolution of human society. When men have arrived at this broader view, they will become reasonable, just in proportion to the breadth of their view. We are safe in saying that centuries may be required in working out the solution to the industrial problem, since this is merely a problem in social evolution. Social evolution is merely the continuous adjustment of social relations to meet changing conditions. As long as these change, we must have the problem with us. It is easy to adjust the parts of a machine. But when each part is itself infinitely complex—is in fact a human being, whose adjustment in industrial relations must be self-adjustment—it is self-evident that any real mitigation of industrial ills must be founded on the gradual growth of intelligence and ethical feeling.—C. V. Corless in September *Bulletin* of Canadian Mining Institute.

Gold received at the San Francisco Mint during September totaled 184,827 oz., including 10,273 oz. of Australian gold and 245,702 oz. in sovereigns (£ or \$4.80 each). The value was \$10,022,263. Silver received amounted to 116,023 oz., worth \$97,825. Coinage consisted of 116,000 half eagles, 2,100,000 dimes, 2,100,000 nickels, and 1,700,000 cents, of a total value of \$912,000. Coin, bullion, etc., on hand at the end of the month totaled \$477,990,352.63.

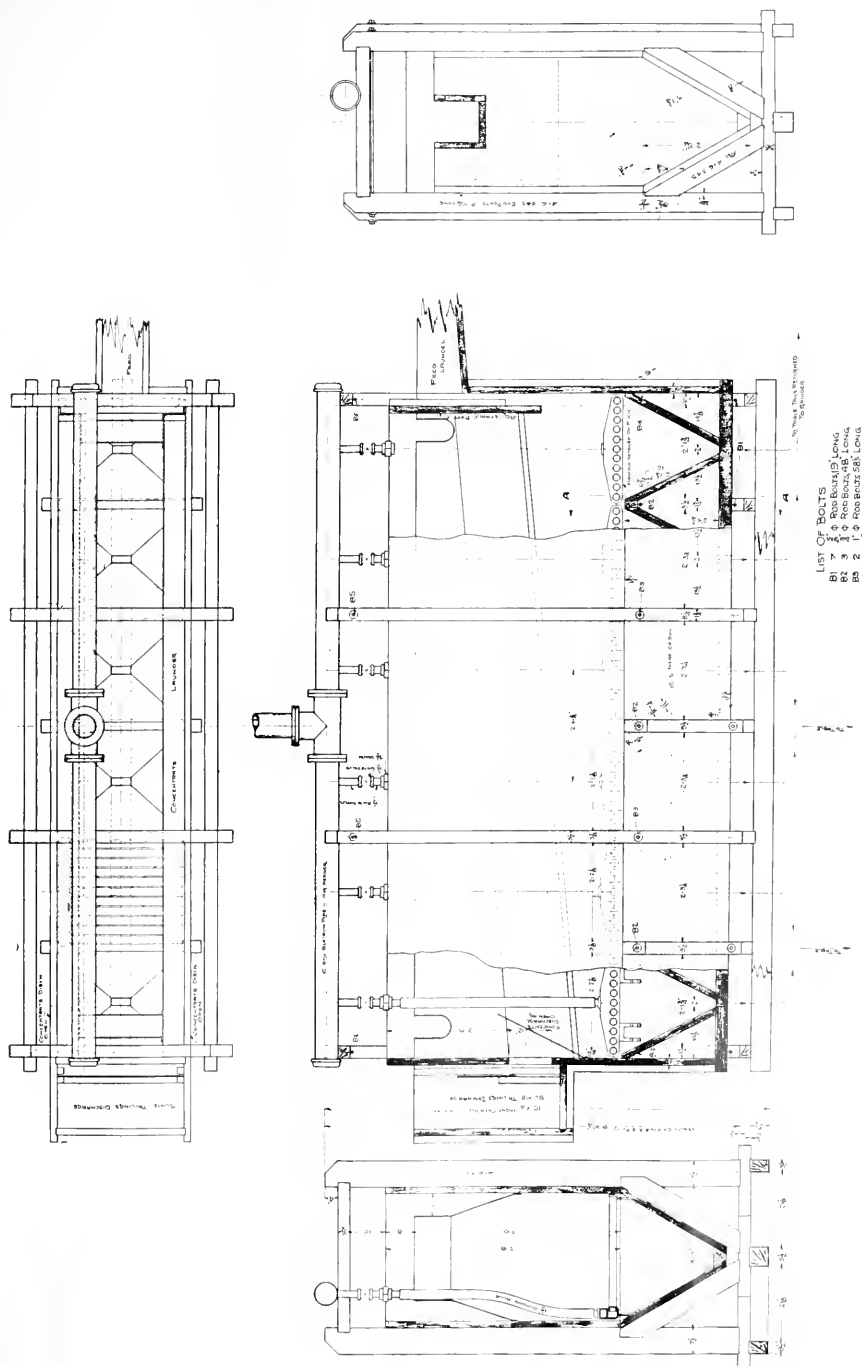


FIG. 9. SPRITZKASTEN FROTHER EQUIPPED WITH TUBE-GRAPE AIR-FILTER.

Life On An Early Geological Survey

By H. Foster Bain

Yielding to the hypnotic influence of some fascinating sketches, I gave in 1910,* some account of early days up-on the Kentucky Geological Survey. I have never since wondered at Dickens having chosen to write of Oliver Twist. Indeed, at times, I have been disposed to believe that the people who boldly demand 'more' constitute a majority. My situation has become almost as desperate as that of the Colorado mine-promoter who once allowed one of his 'tunnel' companies to pay a dividend. He later confided to a fellow promoter that it was the most serious mistake he ever made, as it created a truly insatiable demand for more dividends and finally drove him out of business. Hoping that the results in this case may not be equally serious, I have made a further draft upon the supply of pictures that form the excuse for the existence of my text.

These sketches, it may be recalled, are reproductions of silhouettes, cut at the time by John R. Proctor, who, as a young man was a member of the party whose activities he has so cleverly depicted. They are published through the courtesy of Philip N. Moore, who, despite the many incidents of a busy professional career, finds place in his memory for the days when with A. R. Crandall, C. J. Norwood, Robert Peter, John Hussey, F. G. Sanborne, Lucien Carr, W. B. Page, W. W. Beckman, W. T. Page, and other young enthusiasts, all under the inspiration and direction of 'Uncle Nat' Shaler, he was helping to determine the material foundations of the present prosperous State of Kentucky.

The Survey was organized in 1873, and continuing in full activity till 1894, it contributed an enormous impulse to that industrial development of eastern Kentucky, in particular, that has marked the last quarter-century. Incidentally, the life on the Survey, the associations then built up, and the solid knowledge acquired in the course of the work, contributed also to the making of a number of useful careers in our profession. Even those who were members of the staff but a short time look back with pleasure and gratitude to their Survey days. It is a bit difficult for the historian, gazing at the massive structure and considerable atmospheric displacement of so vigorous a man as J. H. De Fries, for example, to realize that any member of the former corps was once considered to be "thin and puny-like" and in grave danger of an early demise unless a course of hardy outdoor life could be attained. Be that as it may, De Fries, the prosperous director of Borax Consolidated and trusted counsellor of London corporations, was, by report, saved to usefulness by the Kentucky Survey. As one gazes at certain other former members of the staff,

he inevitably wonders what they might have been except for those long days of tramping up valleys and over mountains and the nights of solid sleep that follow such days.

Any account of a geological survey party should properly begin with its most important member; and I leave it to any ex-survey man if, not the leader of the party, but the cook does not occupy that rôle. Many a bitter-scientific controversy has waged through the long years because the camp-cook failed at a critical time to keep the geologist well fed and in good condition, and so up



EXHIBIT A. THE SURVEY PARTY'S COOK.

to making accurate observations. I am more than half-persuaded that the numerous proverbs enjoining care on the man who would choose him a wife, grew out of the primitive condition where wife and cook were at best variant names for the same person. In the City, one can if need be, go to his club; or, if temporary difficulties as to the budget superimpose themselves on others domestic, there are the ever present Childs of A. B. C. restaurants, depending on which country you are in, to succor one. In camp in the mountains, one is dependent on his own resources and the tender mercies of a hired cook who probably, with a total disregard of distances involved, from time to time threatens to "quit and go home," unless his every wish be respected. Here is a secret worthy of consideration perhaps by those who frame courses in mining schools—a knowledge of cooking is the one sure road to independence. An engineer who can look the cook straight in the eye, conscious

*M. & S. P., October 1, 1912.

meanwhile of his own skill in flapping pancakes and getting the bacon and coffee just right, and can tell that cook: "Very well, whenever you like, but you had better think it over till morning"—that engineer, I say, is truly independent. He will have, and will deserve, a comfortable camp. It is, however, a risk, because, you see, the cook may take you at your word.

The cook for the survey party of which I write was



EXHIBIT B. BOTANICAL EXPLORATION.

Sam Tutt—fat, lazy and good natured as becomes a camp cook. I present his picture as Exhibit A. Sam was a native, and knew as a true Kentuckian how corn-bread should be made and bacon 'br'iled.' He even, in proper season, concocted wonderful pastry stuffed with the large ripe blackberries which make travel through Middle Western states a delight in summer. Those who have attempted pies in camp, need no higher testimony to his skill and will know at once why the Shaler survey of Kentucky was famous for the friendships formed within its staff.

It was the business of these early geological surveys to make complete studies of the natural history of the regions under survey. It was in the days before the intense specialization of the present, when a geologist, wandering off the edge of the well made topographic map furnished by the engineer, falls headlong into an



EXHIBIT C. EXPLORING CAVES.

abyss and must cry aloud for help to be set again upon his feet. In those primitive days the geologist had interest at least in botany, in entomology, and in kindred sciences. He could himself distinguish between a beech tree and a telegraph pole, and welcomed the help of the botanist who traveled with him and studied timber while he traced the coal beds. So the various scientists traveled the woods and hills together at times even hand in hand, or as nearly that as circumstances permitted, as depicted in Exhibit B.

Kentucky is a land of caves, and in both eastern and

western parts there are miles of caverns, some, as the Mammoth, in which untraced rivers tempt one to explore, others small and unimportant. One can never tell the size of a cave from looking at its mouth, and at the time of which I write, most of the secrets of the caves were yet unknown, the survey staff entered and explored such as they came across. Perhaps it is more correct to say some members did so, since in Exhibit C, Hussey the botanist and Norwood the geologist, seem to have chosen the wiser part, while Carr the archeologist struggles to regain his place upon the upper surface of the earth where men play at making history. One might question the result were it not that 'Uncle Jimmy' Kemp—whose accuracy and veracity the boldest would not call in question—has at various meeting of the Institute and Geological Society presented most convincing lantern slides of himself engaged in even more strenuous feats of climbing.

Every campaign finally closes, and every week of toil has its Saturday night, even in camp. These scenes depict conditions long before the days when the enameled tub so enthused the country guest that he "could hardly wait for Saturday night to come," but, as shown in Exhibit D, the differences between ancient and mod-

ern times are but differences in method and instruments. The essentials, plenty of cold water and a willing or at least acquiescent subject, being present, the result is the same. Even in recent years and at high altitudes in Colorado I have known ambitious graduates of 'Tech' to rig a hollowed half log so as to deliver spring water where it would do the most good.

The last scene, Exhibit E, illustrates a subject that

has ever been a favorite with painters—"After the Bath". While not done entirely in the modern French



EXHIBIT E. 'AFTER THE BATH.'

style, the sketch is still, I think, sufficiently realistic. It being well understood that beyond what Trilby immortalized as 'the altogether' there is nothing more to reveal, this will I hope, excuse me from making further research into the history and doings of the Second Geological Survey of Kentucky.

MINERAL PRODUCTION of Kentucky in 1914 was valued at \$26,668,474, slightly under that for 1913. The products include the following:

Clay products, tons.....	66,229
Coal, tons	20,382,763
Coke, tons	443,959
Fluorspar, tons	19,077
Mineral waters, gallons	437,334
Natural gas, value	\$490,875
Petroleum, barrels	502,441
Sand and gravel, tons	1,563,498

At about \$1 per ton coal forms the largest item in the list. The lead and zinc output is increasing, that in 1915 being 251 tons and 764 tons respectively, worth a total of \$213,006. The deposits are found in both central and western Kentucky. The presence of zinc-blende was recognized in 1854-'57 during the first geological survey of the State by D. D. Owen and S. S. Lyon.

In 1915 there was 370 tons of lead concentrate sold, and 2172 tons of zinc carbonate, the latter an increase of 1528 tons. At the Larue mine, near Marion in Crittendon county, low-grade sphalerite concentrate was recovered from dump ore. An experimental flotation plant was erected. In western Kentucky galena is associated with fluorspar, this being a continuation of the southern Illinois lead and zinc region. At present lead is a by-product of the fluorspar.



EXHIBIT D. 'SATURDAY NIGHT.'

Re-Timbering a Four-Compartment Shaft

By H. G. Thiele

Increasing pressure, due to heavy and swelling ground, was found to be gradually closing the Capote No. 2 shaft of the Cananea Copper Co. In some places the timbers had been cut out to the limit of safety in order to permit the passage of the skips. Besides interfering with rapid hoisting, there was always danger of a serious accident.

The new Capote No. 15 shaft was not ready for use, therefore, in order that production from the Capote mine might not be curtailed, it became necessary to re-timber No. 2 shaft with as little interruption as possible. This was done by dividing the work into two operations. Several months were required for the preliminary preparations while only a few days were necessary for the actual removal of the old timbers and their replacement.

The shaft was first plumbed to the 600-ft. level by letting down three plumb-lines from the collar-set at

to work after the night-shift had left the mine and hoisting had been discontinued. In this way they were enabled to work from 2 until 6.30 a.m. On entering the shaft they first built a temporary platform in the shaft, at the station below the point where they intended to work. This served to catch the rock and timber removed in setting back the lagging. Two men at work on the level below were able to remove the material dislodged and dump it into old stopes behind the shaft. In most cases it was necessary to chop out the old sheeting before it could be removed. Where the rock was hard it was necessary to drill and shoot short holes in order to loosen the ground. However, in most places it was soft and broken, so as to permit removal with a pick. In this way the shaft was enlarged about 18 inches, for the height of one set, around three compartments. Two

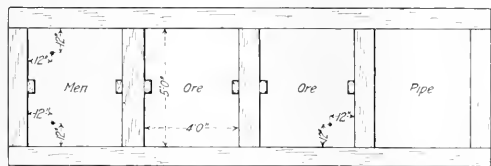


FIG. 1. PLAN OF SHAFT SHOWING POSITION OF PLUMB LINES.

surface, as shown in Fig. 1. The distance of the timbers from the plumb-lines was measured at intervals of every third set. These results when plotted gave a graphic record of the condition of the shaft. In one place it was found to be as much as 11 inches out of plumb. It was then decided to re-timber the three compartments used for hoisting men and ore, and to leave intact the fourth compartment, which contained the pipes and wiring.

The preliminary preparation for re-timbering consisted in tearing out the old sheeting and inserting new lagging 18 inches back from the shaft-timbers, as shown

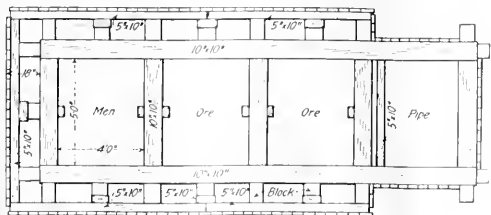


FIG. 2. PLAN OF SHAFT SHOWING PONY-SETS.

in Fig. 2. This was done only in the three compartments that had to be re-timbered.

The work was done by a crew of eight men who went

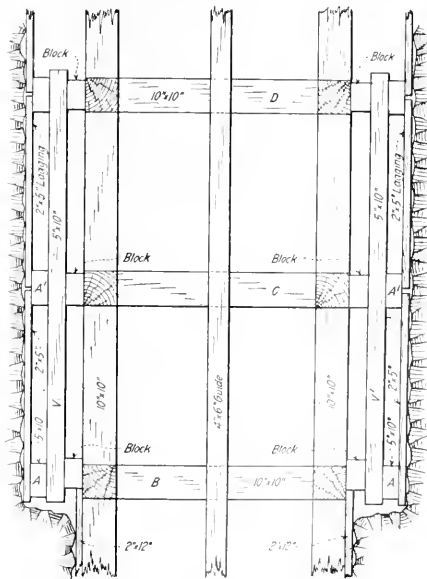


FIG. 3. SECTION OF SHAFT BEFORE REMOVING SET C.

transverse timbers, Fig. 3 (A and A'), 5 by 10, were first set in place and blocked loosely against the wall-plates. After the lagging had been set in place, wedges were driven between the blocks and wall-plates opposite the posts. The same operation was done at the end of the last compartment except that the blocking was against the end plates. When complete the result was a short pony-set extending around three compartments. As the timbers were not to be removed in the pipe-compartment,

5 by 10 sprags were wedged between the wall-plates of every set a few inches back from the dividers. Short posts were wedged between the wall-plates opposite these sprags. Fig. 2 gives the plan of a set after the lagging had been set back. This operation should be conducted from the top of the shaft downward in order to prevent 'runs' of loose material into the shaft. All platforms and obstructions had to be removed from the shaft at the end of each shift, leaving it free for hoisting. Care and judgment were necessary so that the work might be left in condition to prevent all danger of loosening during the hoisting on the day-shift. Progress depended on the nature of the ground surrounding the shaft.

Several months were necessary to prepare the first 300 ft. of the shaft as just described. In the meantime the new timbers had been framed, each set and piece being numbered so as to facilitate handling in the shaft.

As work in the mine was usually suspended on the first and fifteenth of every month for pay-day, one of these intervals was chosen to begin the work of removing the old timbers and replacing them. Accordingly the first set above the brow-set of the 400-ft. station was chosen as the starting-point. In this operation the work must proceed from the bottom upward. It was first necessary to build a platform of planks in the shaft, level with the floor of the 400-ft. station. This was needed to prevent the material removed from falling into the sump. Temporary platforms were also built in the shaft above the 300-ft. station as a protection to the men working beneath that point. It was possible to lower one cage to the 300-ft. level. All the new timber had previously been lowered to that level, each set being piled separately.

Referring to Fig. 3, *B* was the brow-set and *C* the first set to be removed. The vertical stringers *V* and *V'* had been blocked in place in the middle of each set and at the end, as seen in Fig. 2, to hold back the transverse timbers *A* and *A'*. It was necessary first to remove the guides, which was done by withdrawing the lag-screws to the nearest joint below set *B*. The guides, and all other timbers subsequently removed, were lowered to the platform at the station below the point of removal and stored on that level.

In order to remove set *C* it was necessary to block up set *D* so that the shaft might not be loosened and break away above that point. In each compartment a 10 by 12 timber (See Fig. 4) was thrown across the shaft on top of the wall-plates of set *B*. On this was raised stulls *S* and *S'* supporting another 10 by 12 timber, which received the wall plates of set *D*. The stulls had to be set in the compartment in order not to interfere with placing the new wall-plates. The first set *C* was now ready to be removed. It was necessary to chop off the blocks before they became loosened sufficiently. In most cases it was easier to cut through the dividers than to attempt to loosen the blocks. Next, the posts supporting the set were sawed and chopped off in order to drop the set. The wall-plates were sawed a few inches from the dividers in the pump-compartment. As each timber was

loosened it was lowered to the station below and not dropped as that would have damaged the temporary platform. All was now in readiness for placing the first new set.

The wall-plates to facilitate handling had been framed in two sections, one length of which was equal to the

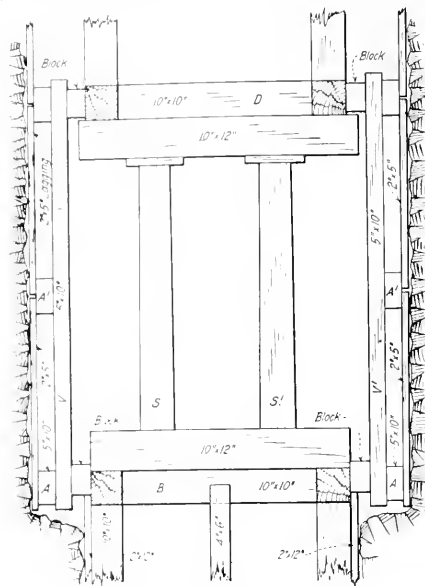


FIG. 4. SECTION SHOWING SET C REMOVED.

width of two compartments and the other to the width of the remaining compartment. All the joints and splices had been drilled for wooden pegs. The posts were lowered and set in their places on the old set (*B*), each having been cut to such a length as to bring the first set level. Next the wall-plates were lowered and put in place, after which the end plates and lastly the dividers. The set was assembled ready to be blocked. Plumb-lines were now dropped from above and the first set blocked to correspond to the collar set.

Before removing the next set *D*, it was necessary to support the set above, which was done by laying a stringer on wall-plates of new set *C'* and raising the stulls with stringer under the wall-plates of the set above *D*. Before removing the stulls supporting set *D*, short posts were placed on new set *C'* to receive weight of set *D*, while the transfer was being made. New vertical stringers corresponding to *V* and *V'* had to be inserted, reaching from new set *C'* to set above *D*. The short posts supporting set *D* could then be removed and a few blows would usually cause the set to fall apart. A new set was then assembled in place and blocked the same as the set below.

Replacing the station sets was a little more difficult although carried out by the same method as used in replacing the ordinary sets. Bearers were introduced at intervals of about 100 ft. and usually a short distance

below the stations. On completing the work the vertical stringers V and V' were all removed, as the transverse timbers A and A' had been securely blocked against the new sets. The sets were all framed from 10 by 10 Oregon pine of the best grade. The lagging was heavier than is usual.

A crew of 18 Mexicans, supervised by two Americans, worked on each shift. It was possible to remove and replace an average of two sets on each shift. The following distribution of the working crew was made: 8 timbermen working in the shaft; 3 men on station for removing timber and loose material; 3 for handling and lowering the new timber; 1 engineer for small air-hoist and 3

roustabouts for odd jobs such as bringing in sharp tools, drinking-water, and wedges. With an American crew two-thirds of the number could probably have done the work. A suggestion for avoiding delay, although it may seem obvious and insignificant, is the need of a sufficient supply of sharp tools always on hand. In the beginning more delays were caused by dull tools than from any other cause. Extreme care was necessary at all times in order to prevent accidents. Fortunately the work was finished without a single accident of any kind. The work was done under the direct supervision of R. Z. Hodges as foreman and Thomas Stanton as superintendent.

Gold Mining in War Time

In the last issue to hand of the 'Monthly Journal' of the Chamber of Mines of Western Australia, an interesting editorial has the above title. It has never been possible to carry on operations in the western State under as advantageous conditions as in the other States. The mines of the West are far inland, in an almost waterless and desert country, with little facility for the local production of foodstuffs. Gold to a depth of 200 to 300 ft. is oxidized, amenable to simple treatment; but the sulpho-telluride ore at depth requires special and costly methods. The standard of wages has always been high, rendered necessary by the high cost of transport, living, and other conditions. With depth the grade of ore has decreased from \$14.40 per ton in 1893 to well under \$9.60 at present, while the profit in 1903 was \$4.44 and today \$1.44 per ton. Large tonnages have to be treated now to make a decent return on the capital.

The War has intensified all of these factors, added to which was the difficulty in securing such supplies as zinc sheets, explosives, lead acetate, quicksilver, cyanide, and special parts of machinery, none of which were made in Australia. The Chamber of Mines took prompt steps to secure supplies, and these are now arriving regularly. The great benefit of the Chamber's organization has been proved, for if the companies had acted individually many would have been forced to suspend work. The following shows increases in some of the mine supplies:

Per cent increase since the War

Manila rope	25.0	Cement	52.7
Shoes and dies	20.4	Explosives (gelignite) ..	25.0
Fuse	8.0	Welsh coke	36.9
Clay assay crucibles ..	36.1	Lead acetate	97.7
Retorts	14.1	Borax glass	38.3
Litharge	15.5	Quicksilver	114.4
Bicarbonate of soda ..	13.4	Zinc shavings	85.2
Galvanized iron	64.0	Cupel material	13.1
Steel plates	42.6	Bar iron	48.0
		General hardware	20 to 25

Oils have advanced from 3 to 4 cents per gallon. In June, 1914, one mine at Kalgoorlie had stores costing \$14,900; a year later these cost \$17,800. Since the latter date there have been further advances in prices.

Many of the best men employed at the mines have gone to Europe, resulting in a shortage of labor. The Unions

acted foolishly regarding certain unnaturalized foreigners at the mines, which re-acted against the labor supply. Increases in wages are being demanded. The general result of the labor attitude was to reduce the output of nine large mines at Kalgoorlie by 5300 tons and \$32,000 gold weekly. The monthly output of this district is nearly \$1,100,000 from 132,000 tons of ore. The total to date is over \$300,000,000.

Additional taxation is another grave disability. Mining raised Western Australia from poverty, obscurity, and stagnation to prosperity, prominence, and progress. The State and Federal governments are making undue levies on the mining industry, which is willing to bear its fair share. Impositions consist of the State income and State profit, and Federal income and Federal land taxes. In addition to these the Commonwealth government has a bill to levy a war-profits tax. This requires 50% on all profits that exceeded by more than \$960 the normal standard of profits made by any business prior to the War, calculating an average of three years preceding August, 1914.

Western Australia has produced gold worth \$577,000,000, of which \$124,000,000 has been paid in dividends.

THE COST OF OPERATION has been much higher during the past six months. Wages have been advanced, and an eight-hour day introduced at all points. The cost of materials has been advanced 50% and, in more than one instance, over 100%. On this account the profits per ton of ore smelted, or bullion refined, has been seriously reduced, due to the fact that the toll received from the mines and smelters has been fixed on long-time contracts, made when present costs were not believed possible. The present favorable showing as to profits is due, partly, to a large and abnormal increase in business, but, to a great extent, to the production of A. S. & R. Co. mines and to new lines (tin) of business in which the company has interested itself, and which, it is hoped, will be increasingly profitable. A few years since, the business of the company was almost entirely the smelting of lead and silver ores, and the refining of the resulting bullion. This portion of the company's business has been far less profitable per ton of materials handled than during the same period of last year.—Abstract from half-yearly report of A. S. & R. Co.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

A SCARF SAMPLE is one that is taken over the full width of a vein by cutting a groove across the face of it.

SULPHATE OF ALUMINA is used for clarifying water. Present quotations are from \$120 to \$185 per ton.

USING A FUSE with its detonator to bind together sticks of powder into a bundle is a very dangerous practice, although not uncommon.

CARBONIC ACID GAS pockets are encountered in magnesite mines, and have been known to result in suspension of work in that ground until cleared by other openings.

OIL CONSUMPTION in calcining refractory magnesite ore in Sonoma county, California, is one barrel per ton of calcined product; or one barrel for two tons of crude ore, as practically half of the ore is carbonic acid gas.

MAKING WIRE is one of the oldest of the metal arts. The first wires were rolled from thin strips of metal. Wires of gold and silver have been recovered from the graves of the ancients in Asia, Africa, and in South America.

WELL-EQUIPPED MACHINE SHOPS are of importance to large dredging companies, most of which in the United States are so equipped. The Conroy company at Ruby, Montana, spent \$50,000 on its shop, where 24-ton parts are repaired.

PORTLAND CEMENT for underground work is used in increasing quantities. It has been utilized recently to close water-channels in wet ground, by forcing cement into the rock in advance of the drills by means of a powerful pump.

SPARE PARTS for repairs must be always ready to install on dredges. Most of these are heavy and expensive. The Conroy company, at Ruby, Montana, finds it necessary to keep on hand at least \$60,000 of material for its large boats.

CEMENT produces a peculiar skin eruption, resembling the itch. It is caused by the alkaline content of the concrete acting on the skin, especially where already softened by water. Covering the skin with fat or grease and careful washing will largely prevent the inconvenience.

PLATINUM will not amalgamate with quicksilver alone, but will if sodium is added. In ordinary quicksilver amalgamation, the flakes of platinum float on the surface and can be removed. If sodium is used the platinum may be separated from gold by agitating the amalgam with water until the sodium is used up to form sodium

hydroxide, when the platinum will come out on the surface of the amalgam, provided, of course, that it is sufficiently liquid.

LIQUIFIED CHLORINE GAS, obtained by great compression, or by intense refrigeration, has become an important article, which can be transported in strong steel cylinders. Its main use is in the manufacture of tin chloride by the Goldschmidt process for reclaiming tin scrap.

NICKEL in considerable quantity, probably between 700 and 1000 tons, is produced as a by-product in the electrolytic refining of copper in United States. Most of the metal is produced in the pure state by electrolytic processes although a great deal is marketed as nickel salts for use in plating.

CONSTANT ATTENTION should be given to mine-ladders. Frequent inspections should be made to see that the fastenings are secure and that there are no loose or broken rungs. Care should be taken to see that pieces of broken rock do not become lodged behind the rungs where they may be loosened and fall on the men using the ladder-way.

Lack of proper illumination causes from 10 to 25% of all industrial accidents. The approach of winter makes it necessary to overhaul surface-lighting apparatus at mines and mills, which, during the summer months, is not used as much. A well-lighted corner prevents accidents, and is more comfortable for employees to work in.

FOREMEN at the Ford motor factory, Detroit, are not allowed to discharge men. According to D. S. S. Marquis, head of the educational department, taking this right away from foremen is the greatest thing they ever did at the works. From June, 1915, to August, 1916, there were hired 21,663 men. Of these, 5680 left, and only 5 were discharged.

A HOISTING ROPE in use is continually subjected, not only to the wear of the drums, sheaves, or rollers, but also to a constant wear and friction on the inside, due to the wires in the strands moving slightly when the rope is bent. To be of value the lubricant should not only penetrate to the centre of the rope, but should also thoroughly coat the inside wires.

MOLTEN COPPER is transferred from converters to casting machines in cast steel ladles lined with fines screened from ores regularly used as converter fluxes at the Arizona Copper Co.'s smelter. Bars are cast in molds made of converter copper. A 1½-in. cast-iron splash-plate covers half of the bottom area, and an average of 73 tons of bullion is cast per mold. Bars weigh 240 lb. each, and 35 minutes is required for casting a charge weighing seven tons. Considerable chipping of bullion bars is necessary to remove edges and fine shot due to blowing to gas finish of 99.60% copper.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

REDDING, CALIFORNIA

NOTES ON SHASTA AND TRINITY COUNTIES' ACTIVITIES.

After a series of experiments extending over eight years, the Bully Hill Copper Co. has devised an electrolytic process for recovery of zinc from the complex copper-zinc ores of the Shasta copper-belt. The unit in commission at Winthrop has demonstrated the commercial value of the process, which will be utilized in the large plant that the Mammoth Copper Co. is constructing near Kennett. Metallurgists from Broken Hill, Australia, are at Winthrop studying the system for probable application on the zinc concentrate of that centre. Experiments indicate the process will extract zinc and other metals from the fine dust deposited in the bag-house of the Mammoth smelter.

The Mammoth smelter is reducing approximately 1200 tons of material daily, of which 900 tons is ore, including 300 tons smelted for the Balaklala company. The Mammoth ore averages 3 to 5% copper, about 4% zinc, and \$1.50 to \$2 gold and silver per ton. Considerable high-grade zinc has been opened recently in the Mammoth mine. Driving of the Mammoth and Friday-Lowden tunnels is making good progress. The tram to the smelter from the Stowell mine has been completed. Arrangements have been made for building a new boarding-house and other structures.

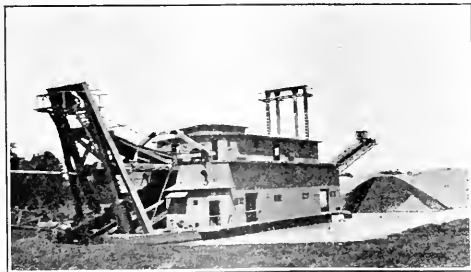
REDDING. The accompanying photograph shows a new Union Iron Works dredge constructed on Clear creek, 5 miles from

As soon as the old workings are repaired vigorous development is to be done. Much ore is believed to exist in old workings.

The first payment on the Bell Cow gold mine, on Arbuckle mountain, has been made by T. F. Ames, Mrs. Frank A. Greene, James Long, and Frank A. Greene. The new owners started work about two years ago, and have opened a strong vein of medium-grade, free-milling quartz. Mill tests have proved satisfactory. The mine is near the road between Redding and Harrison Gulch.

Gold-dredging in Trinity county is steadily gathering importance. The new boat of the Pacific Dredging Co. is rapidly nearing completion at Carrville, and is scheduled to go into commission within 40 days. It is equipped with buckets of 9.5-cu. ft. capacity, and will operate in Morrison gulch. The company continues to prospect large areas with drills, and has proved a broad acreage outside of the main holdings. Near Junction City the Valdor Dredging Co. is completing a large dredge. The dredge of the Trinity Mining Co. is working steadily near Lewiston. A number of dredging projects are receiving consideration in other sections of the county.

The Hess gold mine in the Hess district, a few miles from Alturas, has been equipped with a small mill that is said to be making an excellent recovery. Development has attained a depth of 200 ft., and near this point the main vein is about 18 ft. wide, with the quartz averaging \$10 per ton. Work has been started to open the vein at a deeper point.



NEW DREDGE NEAR REDDING, CALIFORNIA.

Redding, for L. Gardella of Oroville. The buckets are of 7½ cu. ft. capacity, and are of manganese-steel. The boat is arranged to dig 35 ft. below water and has a capacity of 125,000 cu. yd. per month.

The Michigan copper claims, near the Bully Hill mine, are being operated under bond by M. E. Dittmar of Redding, and San Francisco associates. L. C. Monahan is in charge. A good quantity of shipping ore has been extracted, and promising ground is under development. The Michigan has been idle several years, but at one time produced much ore of good grade. Some work is going on at the Arps, Shasta Belmont, and other properties in this district. The ores contain considerable zinc, and the Bully Hill electrolytic process is expected to revolutionize mining throughout the east-side field.

The Minnesota copper mine, between Iron Mountain and Keswick, has been re-opened by Denver people after several years' idleness. George F. Graves has been placed in charge.

SUTTER CREEK, CALIFORNIA

LABOR.—OLD EUREKA, BUNKER HILL, AND KENNEDY.

A meeting of the striking miners was held here on Friday evening, the 6th, when one of the walking delegates of the Union used all his powers to convince the men that success awaited them if they would continue to hold together and that the mine-owners could not long withstand their demands; but it appeared that his remarks did not find favor among the men present, as Union men and others began leaving the hall long before he concluded his remarks, and when he had finished only three men remained in the hall. It is stated on good authority that the South Eureka men will return to work on the old basis on Tuesday morning, the 10th.

The shaft at the Old Eureka has been unwatered and repaired to a depth of 750 ft. An extra crew started on October 8 at construction work. The new steel head-frame is now to be erected, as the work of laying foundations and grading for same has been completed. The new double-drum hoist and other modern equipment will be the means of much better headway being made in the shaft-work from now on. An encouraging discovery was made during the week when men engaged in cleaning-out a drift on the 500-ft. level uncovered a vein of good-looking ore. The vein pitches south toward the Central Eureka ground, and where opened is about 5 ft. wide. This would appear to prove the truth of rumors afloat concerning the good ore left in the mine when early-day methods made it unprofitable to extract ore that now pays dividends.

At the Bunker Hill mine near Amador City, 17 men are working in the shaft completing repairs, and a number of others are engaged in erecting concrete ore-bins and making other improvements of a permanent nature at the collar of

the shaft. Masked men, supposed to be striking employees from that mine, have stopped others on their way to work there during the week, and ordered them not to work. R. Christiansen, the foreman, has been sworn in as a deputy-sheriff, and now accompanies his men to and from work. Some of the shaft-men claim that attempts have been made to photograph them on their way to the mine, and they think that this is a move on the part of the strikers for the purpose of future identification or blacklisting in Union camps. No violence has been undertaken since sheriff Lincot and U. S. deputy-sheriff Hartz have shown their ability to cope with the situation. The trial of two men who are accused of attempting to injure employees has been postponed until Saturday, the 11th.

At the Kennedy mine, three large new boilers are being installed, so that when the men resume work there will be no need of laying them off for this purpose. The superintendent, of the Kennedy, Webb Smith, and N. S. Kelsey of the Argonaut, have each expressed themselves as willing to commence operations as soon as a sufficient number of the men show a disposition to resume work, so it is hoped that work will soon be in progress all along the Lode.

In the Pine Grove district there is more activity than usual. R. Robinson has just finished cross-cutting a wide vein in the Reward mine. It is about 25 ft. wide, 8 ft. of which is good ore. The Pine Grove Mining Co. started its little mill during the week, and by continued stoping the management expects to mine sufficient ore to keep the stamps dropping steadily.—A large body of high-grade ore has just been opened at the Kerckoff mine above Defender; while some good-looking ore has been developed in the mine on the old Stirnman homestead.

TORONTO, ONTARIO

PORCUPINE, KOWKASH, AND KIRKLAND LAKE DISTRICTS.—MOLYBDENUM.

The Hollinger Consolidated at Porcupine is planning to effect a reduction in haulage costs by the adoption of the flow system with underground bins when the central shaft is in operation next spring. The ore will be carried in trains driven by electric locomotives along the haulage-level to the main shaft and tipped into 750-ton loading-pockets, from which it will be drawn-off and the large lumps crushed, and then be raised in 5-ton skips. At the top of the shaft the ore will be dumped into crushers, and after being reduced will drop into 500-ton storage-bins cut out in the hillside adjacent to the central shaft. From storage it will pass by an inclined tram to the top of the mill and be distributed to the stamp feeders. This system will utilize gravity to the greatest possible extent, and will also avoid the necessity of building and heating outside storage-sheds.

At the Davidson the main vein on the 300-ft. level is fully 15 ft. wide, showing visible gold ore, and the ore has been cut and cross-cutting started at the 300-ft. level.

Shareholders of the Apex have voted a dividend to issue \$100,000, half of the per share to come from the development, and the other half from the operating account.

A new vein 15 ft. in width has been found in the Newray east of the shaft, making the total discovered since operations were resumed.

A contract has been let for level 220 ft. and level 240 ft. diamond-drilling on the Thomas Hannah claim.

Development continues at Tebota, and Kowkash, by the Porcupine Gold Mines, Ltd., which owns 24 claims in the Tebota district, in addition to one (600 ft.) the King Pool and two properties at Kowkash. On the Apex claim, Tebota, a new vein has been discovered, 15 ft. wide, and 25 ft. deep, carrying low-grade free gold, and a great deal of pyrite, which is being treated on the surface. On the Davidson Mine the vein 15 ft. wide at the top of the

an 18-ft. shaft. Diamond-drilling has proved the vein at a depth of 125 ft., where it has widened considerably. Some additional discoveries have been made on the King Dadds property, and adjacent claims are being prospected by the Tash-Ori to pick up the original discovery vein.

The Lake Shore Co. of Kirkland Lake, will finance the erection of a 100-ton mill by the issue of 150,000 shares of treasury stock, making the third mill in the district.—The vein found on the McKane property at Kirkland Lake, under option to the Beaver, at the 300 ft. level is 40 ft. wide and will average about \$9 to the ton. A 12-drill compressor plant is being installed.

A rich gold discovery is reported at Bourke's station, mile 181, on the Temiskaming & Northern Ontario Railway. A settler named Anderson uncovered the vein when clearing his farm. It is rich in free gold and has been traced a considerable distance. The announcement of the find has resulted in a rush of prospectors to the neighborhood.

As a result of the demand for war munitions, molybdenum extraction appears likely to take an important place among the mining activities of Ontario. On September 21 the first ferro-molybdenum commercially produced in Canada was run at the plant of the International Molybdenum Co. at Orillia, where three furnaces are now in operation. The Hamilton Molybdenum Alloys Co., Ltd., capitalized at \$500,000, James Harris, president and managing director, is putting in modern machinery for the development of Hamilton mine No. 2 near Norland, Haliburton county, and anticipates putting molybdenite on the market at an early date.

The following notes are part of the half-yearly report of the Ontario Bureau of Mines, the first half appearing last week:

COBALT. With the outbreak of War the European market for cobalt oxide was suddenly cut off; however, new markets and new uses for metallic cobalt have improved the situation. High-grade steel is now produced, using cobalt alloys. Metallic cobalt production is greatly in excess of last year.

NICKEL. Metallic nickel from cobalt ores is produced at the refining works of the Deloro Smelting & Reduction Co., formerly known as the Deloro Mining & Reduction Co. The output shows an increase over that of 1915, which was not marketed during the six months' period.

NICKEL COPPER MATTE. The smelters of the Canadian Copper Co. at Copper Cliff and the Mond Nickel Co. at Coniston are turning out nickel-copper matte at an unprecedented rate. The production, as compared with the first six months of 1915, shows an increase of nearly 40%. The valuation of the metallic-contents of the matte has been made on a basis of 10c. per pound for copper and 25c. for nickel. The figures given for metallic copper and nickel separately show that the prices were over 18 and 12c. per pound, respectively. The British America Nickel Corporation is soon to start at Sudbury.

In addition to the above mentioned companies the Alexo mine, near Porcupine Junction, produces a small amount of nickel-copper ore, which is treated at the Coniston smelter.

MOLYBDENUM. This mineral occurs widely in Ontario, but is mined chiefly in Renfrew county. It is required at the present time for use in the manufacture of high-speed tool-steel, and for this purpose molybdenum will probably replace tungsten to some extent. The demand for molybdenum steel to be used in munition factories comes largely from the Allied nations—Britain, France, and Russia. Molybdenite concentrates containing 85% or more of MoS₂ are worth about \$1 per pound. Ferro-molybdenum is now (September) being manufactured for the first time in Canada by the Orillia Molybdenum Co. at Orillia and the Tivani Electric Steel Co. at Belleville.

IRON. At the Porcupine, the only shipments of iron ore were from the Alexo mine operated by the Algoma Steel Corporation of S. O. Ste. Marie. Although iron-ore production shows a decrease compared with the same period in 1915, that of the iron shows a material increase, both in tonnage and value.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JUNEAU. In its issue of Sept. 25, *The Alaska Daily Empire* includes an additional 40 pages comprising its 'Development' number. The matter is of considerable interest. Special articles include 'Mining and its Bearing on the Future of Alaska,' by B. L. Thane; the 'Alaska Juneau Gold Mine,' by P. R. Bradley; 'Mining Development in Alaska,' by William Maloney; 'Development at Treadwell'; and 'Water Power of Alaska,' by C. L. Andrews, followed by interesting notes on the great fishing industry, furs, agriculture, scenery, the development of Juneau, Skagway, Douglas, transportation, the proposed Gastineau Channel bridge, and education.

August returns from the mines on Douglas island were as under:

	Alaska Treadwell	Alaska Mexican	Alaska United
Broken ore in stopes, decrease or			
Increase, tons	- 9,842	- 5,411	+ 10,056
Stamps dropping	120	150	300
Time worked, days	20.31	30.67	30.61
Ore crushed, tons	13,160	24,696	29,889
Gold from all sources	\$30,538	\$78,196	\$102,900
Yield per ton	2.32	3.16	2.10
Operating profit	13,772	32,997	14,618
Construction charges	4,606	17,585	14,485
Other income	3,730	11,281	3,730

The Treadwell company reports that on July 27 surface evidences of a hanging-wall subsidence near the Treadwell-United-700 Ft. Claim boundary-line began to be manifest, and therefore it was deemed advisable to discontinue the heavy drawing on reserves of caved and broken ore in order to protect the future of the Treadwell, 700, and Mexican mines. The drawing of this ore had been particularly heavy in the Treadwell mine for the reason that the development done on the 1950, 2100, and 2300-ft. levels has so far found very low-grade ore, verging on the limit of being profitable or not. This protective action has necessitated the shutting-down of the 240 mill and half of the 300 mill, on August 1. The time run by the 240 mill in August was 10 hours and 34 minutes, to clean-up the ore that was left in the bins after tramming of ore to the mill had ceased. The power used for the time run was electricity. On August 1, operation of the 300 mill was reduced to 150 stamps, the time run being 30 days, 16 hours, 3 minutes, of which water was used for power 16 days, 7 hours, 31 minutes, and electricity 14 days, 8 hours, 32 minutes.

During September the Alaska Gold Mines Co. treated 135,750 tons of \$1.30 ore. Heavy storms interfered with haulage of ore.

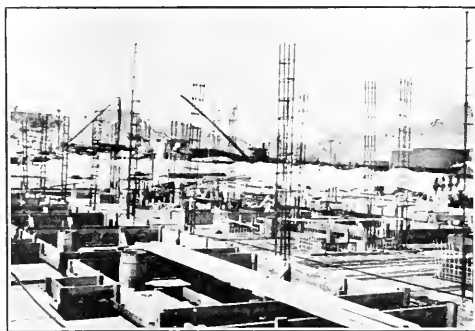
KNIK. The Talkeetna Mining Co., of Seattle, is building a mill on its mine near Knik. The company ordered by wire from the Denver Quartz Mill & Crusher Co. a quartz mill and feeder. This is the third shipment of Denver quartz mills to leave Denver for Knik during the past 12 months.

NOME. New York people have formed the Alaska Mines Corporation to acquire the ground and dredges of the Nome Consolidated.

WRANGELL. The Bon Alaska Mining Co. has been financed, and grading for a 10-mile railway, from the mouth of Mill creek, which empties into the sea 10 miles from Wrangell, to Groundhog basin, is to be started. The mine has a good deal of gold, silver, lead, and zinc ore developed, and next spring shipments of 600 tons daily are contemplated.

ARIZONA

In Bulletin 29 of the University of Arizona Bureau of Mines, Allen T. Bird describes the resources of Santa Cruz county in 27 pages. The earliest mining known on the Pacific Slope of the United States was done in this region, which has witnessed events of historic interest. The greatest length of the county is 50 miles, and width 30 miles. Two branches of the Southern Pacific pass through. Wagon-roads are being improved. The mountain ranges vary from 5000 to 9000 ft. in height, the highest peak being 9432 ft. The principal mining districts are the Nogales, Patagonia, Palmetto, Harshaw, Red Rock, Wrightson, Tyndall, Greaterville, San Cayetano, Pa-



FOUNDATIONS FOR TWELVE 48-IN. SYMONS FINE DISC-CRUSHERS, TO CRUSH 5000 TONS OF 3½-IN. ORE TO ½-IN. MESH IN 16 HOURS, AT THE CORNELIA COPPER MINE, AZO.

jarito, and Oro Blanco. Igneous and sedimentary rocks occur in great variety. The veins carry gold, silver, lead, copper, zinc, tungsten, and molybdenum. Early development resulted in production of lead and silver; copper increased with depth. In the Patagonia mountains there are large deposits of copper-bearing porphyry, one being at Red Hill at the north end. The Duquesne Mining & Reduction Co. at Duquesne, 3 miles north of the Mexican border, is treating zinc-copper ore by flotation. In the Patagonia district are 40 promising groups of mines, some producing. In the Palmetto district are the Three R mines, which have yielded a lot of high-grade copper ore. In the other districts are many mines with good futures.

CHLORIDE. According to Frank Stoffee, who recently completed a mill for the Butte & Arizona company on Stockton hill, he has completed arrangements for construction of a 500-ton mill at Chloride. This plant will act as a custom mill, treating old dumps and current ore from the mines.

GLOBE. Eight to ten per cent copper ore has been opened on No. 16 level west in the Old Dominion. The ore is oxidized.

MIAMI. Erection of steel for the additional two units at the Inspiration mill is finished by the Kansas City Structural Steel Co. The residue is filling the dam across Webster gulch so that before long another lot of launders must be erected.

The following statement has been issued by the Miami Copper Co. regarding the suit of Minerals Separation for infringement of patents in the flotation process, which suit was decided against the Miami: "The bulk of our recovery of copper

is by table concentration. The decision only affects a comparatively small additional saving that is made by flotation, and our counsel are confident this decision will be reversed in higher courts."

ARKANSAS

FORT SMITH. The Arkansas Zinc Co. has decided to add another block of retorts, 800, to its present three blocks of 2100 retorts.

MURRAY. Great things are expected of this zinc district in Newton county. Ore is found at the surface, and is easily mined.

CALIFORNIA

The State Water Commission has been asked for permission by L. G. Sinaard and C. E. van Barneveld to appropriate for hydraulicking 100 cu. ft. of water per second from Slate creek, a tributary to North Yuba river in Plumas county. The proposed ditch will be over 18 miles long, connecting with the Neocene Placer Mining Co.'s Cleveland ditch. The water will be returned to the river.

REDDING. The Potosi gold mine, 6 miles west, after being idle since 1871, is being re-opened in charge of A. S. Howe. The property belongs to the estate of the late Senator J. P. Jones of Nevada.

SAN DIEGO. In view of the interest in metals entering into war supplies, two concise reports, written by F. C. Calkins of the U. S. Geological Survey, on molybdenite and nickel ore in San Diego county, are timely. Mr. Calkins describes clearly the modes of occurrence of the ores and gives helpful suggestions for further development work and prospecting. The molybdenum prospect is in a dike of fine-grained (aplite) containing an average of much less than 1% of the mineral molybdenite (molybdenum sulphide). Only one prospect has been located so far, but the surrounding country is favorable for the discovery of others. The nickel deposit is an irregular body in a dark igneous rock (gabbro) and is shown by Mr. Calkins to have an origin similar to that attributed by most geologists to the famous deposits at Sudbury, Ontario. The nickel occurs in an iron-nickel sulphide (probably polydymite) and assays of more than 1% of nickel have been obtained. Copper is also present in quantities ranging from a trace to 2%, and conditions are favorable for the presence of platinum.

(Special Correspondence.) Development at the Addis & Harral mine near Soulsbyville is progressing satisfactorily. A hoist and compressor are being installed. Sinking is under way on a 1-ft. vein of good ore. The Red Jacket mine in the Rio Oak Flat district is under lease and bond. The property is in charge of Mr. Mont Omery. J. L. Whitney, general manager of the Atlas mine near Tuttle town, has bonded the Boltano mine at Greendale. Extensive development will soon be started. E. H. McMahon county assessor, has opened a promising asbestos mine near Kashida. Samples brought to Sonora show exceptionally long fibers which will make a first class commercial product. At the Harvard mine near Pine town, 60 stamps are crushing continuously.

Sonora, October 1.

COLORADO

CENTRAL COLORADO. Gold output of the district in September was as follows:

Plant	Tons	Average Grade	Gross Value
Golden Eagle	21,000	\$18.00	\$366,000
Pack and	12,164	14.75	166,166
Portland	1,700	9	12,560
Summit	1,500	10	12,500
Island	1,000	16	28,000
Worship Rock	1,000	14	24,000
Total	38,364	\$14.66	\$519,226

This is 21,000 tons less than in August, due to the temporary shut-down of the Portland-Independence, Rex Caley, and Reed mills, which treat low-grade ore.

The Vindicator Consolidated will pay the regular quarterly dividend of 3% and an extra of 3% on October 25.

LA PLATA. The upper and lower districts are busy extracting ore and preparing for the winter. Some mines have shipped rich gold and silver ore.

LA VILLE. Miners here have asked for an increase of wages from \$3.75 to \$4.25 per day. A conference is to be held with the mine managers.

ORAY. The recent development in the Governor mine in the Mt. Sneffles district is producing better ore than expected, and the snaffles have recovered 138 oz. of gold from 4000 lb. of ore.

IDAHO

BURKE. At its Gem mill and at the Federal mill the Hecla company is treating 450 and 300 tons daily, respectively. Additions to the former plant will increase the capacity by 200 tons.

GILMORE. The Pittsburg-Idaho Mining Co. is receiving bids for a new electric power-plant, also hoist, compressor, pumps, etc. An oil-engine is to drive the generator. A. S. Ross is president. Ore shipments in September returned \$57,867 at a smelter in Utah.

KELLOGG. Grading for the Bunker Hill & Sullivan smelter is finished and concrete foundations are being poured.

PINE CREEK DISTRICT. The Constitution Mining Co. is to spend \$26,000 in new plant, to be ready by January 1. A contract for a 100-ton mill has been let.

Unusual activity prevails among the mines of the Pine Creek district, an incentive to development having been given by the belief that the railway lines will be extended to provide transportation for the region.

WALLACE. In the suit of the Alameda Mining Co. v. the Success Mining Co. before a referee, testimony in the accounting case closed on October 3. There is a wide difference of opinion regarding the value of the ore alleged to have been wrongfully mined, varying from \$168 to \$147,761.

MICHIGAN

THE COPPER COUNTRY

DOWAGON. Six of the Calumet & Hecla subsidiaries are now paying dividends, the C. & H. receiving \$2,226,908 so far this year as follows: Ahmeek, \$1,225,600; Allouez, \$287,000; Centennial, \$41,500; Isle Royale, \$98,730; Osceola, \$524,000; and Superior, \$50,078. In all of 1915 the Ahmeek paid \$563,776, the Allouez \$41,000, and the Osceola \$262,000; and in 1914 the Ahmeek paid \$147,072, and the Osceola \$98,250. The C. & H. and properties under its control are employing 12,000 men, 4000 of whom are with the C. & H., which treated 250,000 tons of ore during September.

MONTANA

BUTTE. The Boston News Bureau gives the following information: The Atlantic Mines Co., which three years ago took over the La France Copper Co. property, has been dissolved, and all the property save the cash on hand will be offered for sale at public auction in Butte on November 1, following which a dividend in liquidation will be distributed. The Anaconda company has offered a price for the property which will return Atlantic stockholders the \$250,000 cash originally in the company's treasury when operations started, and a sum equal to the par value of the stock \$10 together with 8% interest per annum, a total of about \$12.50 per share. La France mine was worked about 20 years ago for silver without success, and was closed for several years. Recent work has demonstrated that the principal value, if any, which may be found in the ores, is

in the zinc-content. Heretofore it has been impossible to treat these ores, but the electrolytic process has solved the problem.

The North Butte company proposes to do 3500 ft. of development each month. The Granite Mountain shaft is down 3300 ft., the deepest at Butte.

The Ballaklava is shipping 100 tons of 3% ore daily. A shoot was cut last week at 2600 ft., 30 in. wide and containing 6% copper.

At 1000 ft. the Butte & Zenith has commenced cross-cutting south and north.

On the 1600-ft. level of the Butte & London a manganese-quartz lode, assaying 10 oz. silver per ton, has been cut. It is 35 ft. wide.

The total pay-roll at Butte for September was \$2,189,000.

HELENA. To treat low-grade ore from the Helena district the New York & Montana Testing & Engineering Co. is to spend \$30,000 on a custom plant. C. E. Fryberger is in charge.

SUPERIOR. The Intermountain Copper company will pay its second dividend, of 3c. per share, on November 20. The new 100-ton mill is working well. The product is sent to the B. C. smelter at Greenwood.

TROY. The new 300-ton mill, 1500-hp., hydro-electric plant, and 5½-mile railway, being constructed near here by the Snowstorm company, are nearly complete. The mine contains 400,000 tons of ore assaying 7% lead, 8% zinc, and 3 oz. silver per ton. A recovery of 85 to 90% of the first two metals is expected, and 40% of the zinc. Slime is to be treated by flotation. The Banner & Bangle vein has been developed by 6 adits for 2500 ft., with a vertical depth of 1100 ft. Production is expected to start early in November.

NEVADA

GOLDFIELD. The Silver Pick shaft is down 930 ft., in the shale. The mineralized quartz passed through was 30 ft. thick. No. 2 drill-hole, sunk from the 500-ft. level, reached a depth of 1400 ft. It cut three gold-copper veins which will be opened by subsequent development.

At a depth of 1017 ft. in the Jumbo Extension, near the boundary of the Velvet claim and the Jumbo Junior, a new ore-channel has been opened in the shale. While of low grade this formation is encouraging.

Three rich shoots have been opened at 300 ft. in the Great Bend.

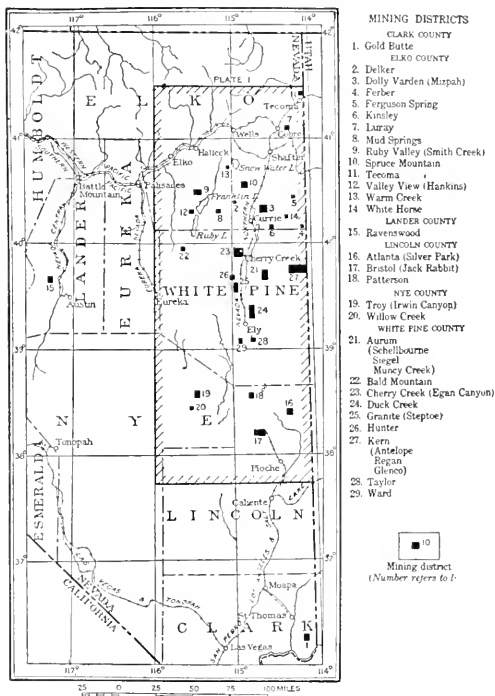
TONOPAH. The Miners' Union is to ask the Mine Operators' Association for an increase of 50c. per day while silver is at the present price.

YERINGTON. During the quarter ended June 30 the Nevada-Douglas company's revenue was \$105,936 from ore and \$88,936 from assessments. In the half-year the profit was \$11,044. During the past 60 days the mill has treated 75 tons daily, recovering 85% of the copper. Six towers, 40-ft. diam. and 20 ft. high, holding 750 tons each, are being erected to leach 3-in. oxidized ore. Sulphuric acid is to be used.

The Mason Valley Mines Co. has issued a report, in which it is stated that the directors will try and raise \$1,000,000 by selling 200,000 shares at \$5 each.

In Bulletin 648 of the U. S. Geological Survey, James M. Hill describes some mining districts in eastern Nevada, the accompanying map showing their situation. This publication covers 214 pages. Striking features of the region are the arrangement of the mountain ridges along northward-trending axes and the wide, flat, barren valleys between them. Eastern Nevada is somewhat better watered than the western and southern parts, and along the east base of the higher ranges are many cattle and hay ranches. Sedimentary rocks have been faulted along a series of north-trending breaks of great magnitude. The sedimentaries are in many places intruded by stocks and dikes of igneous rock, mostly approximately quartz-monzonites or granite-porphyrines in their mineral composition. Generally, the ore deposits are localized about the

centres of intrusion. Nearly all the ore deposits occur in sedimentary rocks, or in granular igneous rocks that have intruded them. The more important deposits can be divided into replacement deposits, contact-metamorphic deposits, and veins. Minerals in the ores total 41. The paper details deposits and



PART OF NEVADA, SHOWING DISTRICTS DESCRIBED.

mines in the Gold Butte district of Clark county, those in Elko, Lander, and Lincoln counties, the Bristol district of Lincoln county, some areas in Nye county, also in White Pine county.

NEW MEXICO

(Special Correspondence.)—A committee of Arizona farmers has recently visited the mills to report progress on tailing-disposal systems being arranged. It is understood that they approved of the precautions the companies are taking at no little expense to avoid running mill residue into streams. The Socorro company is storing its tailing on its own property, while the Mogollon Mines Co. is building a 5-mile flume to convey the waste to a suitable site.

The annual consumption of sawed timber in this district is 500,000 board feet, also about 40,000 lineal feet of round timber underground. Most of this has been furnished by one saw-mill on Willow mountain, now operated by Kelly & Hunter. A plant on Mineral creek was recently completed, with a board-flume 7 miles in length to convey the lumber to the divide just above Mogollon, whence the company has an easy descent for most of its timber. The water, after leaving the flume, will be piped to the base of the mountain, and it is expected to thus develop 250 h.p., sale of which has already been contracted. It is hoped to have the power-plant in commission in the spring.

Two other available power-sites are being considered, either one of which is susceptible to development on a scale sufficiently large to meet the growing consumption. Cheaper

power has long been recognized as the prime factor in arriving at a solution of lower cost of operation, and the long life of the mines warrants a strong appeal to capital for the installation.

September has been another excellent month for local operators. The Socorro Mining & Milling Co.'s properties produced 3300 lb. of gold and silver bullion and the Mogollon Mines Co., operating the Last Chance mine, shipped 2700 lb. for the same period, a total of 3 tons of precious metal in 30 days. In addition, each company shipped to the smelter at El Paso high-grade concentrate in value about equal to the bullion product, the latter going direct to mint.

The development companies also met with encouragement, particularly the Oaks company in the continued improvement of the orebody recently opened on the Queen vein of the Clifton, from which regular shipments were maintained to custom mill by burro. Another young mine, the Eureka, continues to sack high-grade ore for shipment to smelter. Results at a number of claims by prospector-owners were also good.

E. L. Perkins, superintendent of the Mogollon Mines Co., is conducting a series of flotation experiments on local ores; results so far justify the belief that a greatly simplified treatment with a substantial reduction in costs may be evolved. The Mogollon district has a recorded production of upwards of \$15,000,000, largely from an average grade of \$12 ore. This activity has extended over a period of many years, and with comparatively high costs, necessitating more or less selective mining methods. The camp has an immense tonnage of lower-grade ores in reserve. With the reduced costs of operation that will follow hydro-electric installations and the eventual adaptation of oil flotation treatment, these ores should yield as much profit as the higher grades have in the past.

Mogollon, October 3.

OKLAHOMA

CENTURY. The Montreal Mining Co. is to erect a 200-ton mill to supplement the hand-jigs at work. This is a rich mine, controlled by Canadians, and its first 100 tons of ore yielded a product containing 75% zinc-blende, by hand-jigging.

UTAH

ALTA. No. 6 diamond-drill hole in the Old Emma has cut the lead-silver orebody 25 ft. north-east of No. 5 hole. The ore is in brecciated limestone. Preparations are under way to open the shoots discovered.

BENSHAW. To extend the Montana Bingham Consolidated adit 900 ft. the Utah Karns Tunneling Machine Co. is to use the Karns machine, already at work there. According to J. P. Karns the apparatus will advance 15 ft. daily, drilling one shift and clearing away waste on two lifts. The rock at the present face, 1000 ft. in, is a quartzite. The adit is 7 by 7 ft. in the clear. The Karns machine drills a hole 12 in. diam. to a depth of 15 ft., and ordinary machine-drill are employed to drill eight additional holes to the same depth, three across the top of the face above the large hole, one on each side of it and three at the bottom of the breast. To break the ground the ordinary machine-drill holes are loaded with powder. The holes are then cut and lighted so that the small hole immediately above the large hole drilled by the Karns machine is blasted first and the others afterwards. No powder is placed in the large hole. It has taken nine years of work to perfect the present machine which is only one of a number that have been built. It is driven by a 54 in. piston from a 60 in. Rand air-drill, has an 8 in. stroke, and makes 100 strokes of 10 in. per minute under a pressure of 100 lb. The rate of the drill is built in such a manner that the principle of the ton cutting, in or out of the hole. In reality the lift is the rock only. The rate of the drill consists of a 6 in. cutting circle with two runners that keep the hole open and then the 10 in. diameter of the cutting face. The drill travels between 2 and 3 in. per minute.

PARK CITY. The Big Four Exploration Co., treating 750 tons of tailing daily, is recovering a carload of lead-iron and zinc concentrates from this.

The Judge Smelting & Mining Co. hopes to have its new reduction plant complete early in January. The main buildings are roofed ready for machinery.

SALT LAKE CITY. The Utah Copper Co. has filed an application with the State Engineer for permission to construct a canal 7 miles long to connect its mills with the canal that carries waste water from the Jordan river. A pumping station will also be erected. According to D. C. Jackling the company is earning \$1,000,000 per week, including dividends from the Nevada Consolidated. The present output is at the rate of 210,000,000 lb. of copper per annum.

TINTIC. The district's output in September was 37,500 tons of ore and concentrate valued at \$930,000. The Dragon shipped 8000 tons; Chief Con., 6000; Iron Blossom, 4200; Centennial, 3700; Grand Central, 2700; Eagle & Blue Bell, 1300; Mammoth, 2300; and Gemini, 2400 tons.

The last 10 carloads of ore from 1100 ft. depth in the Tintic Standard averaged \$1744 each, or \$35 per ton. The shoot is considered a remarkable one.

In 1915 Utah mines paid \$10,025,000 in dividends; in the current year, for 9 months, the total was \$16,909,405, as under:

	Per share	Amount in 1916	Total to date
Cardiff	\$0.50	\$250,000	\$375,000
Centennial Eureka	1.00	100,000	4,000,000
Chief Con.	0.15	132,000	282,000
Eagle & Blue Bell	0.05	45,000	492,000
Eureka Hill	1.00	10,000	2,000,000
Gemini	10.00	50,000	2,405,000
Horn Silver	0.05	10,000	5,652,000
Iron Blossom	0.25	250,000	2,750,000
Judge S. & M. Co.	0.75	315,000	1,470,000
Lakeview	0.10	50,000	124,000
May Day	0.05	40,000	284,000
Mammoth	0.15	60,000	2,380,000
Pacific	0.01	7,500	7,500
Silver King Cons.	0.30	191,250	1,133,620
Silver King Coalition.	0.45	562,500	14,520,500
South Hecla	0.15	39,525	39,525
Utah Apex	0.37	195,000	321,000
Utah Con.	1.50	450,000	10,760,000
Utah Copper	8.50	13,809,000	46,476,000
Utah Metal	0.50	342,620	1,242,000
Total		\$16,909,405	\$96,716,145

CANADA

BRITISH COLUMBIA

The monthly pay-roll of the Consolidated Mining & Smelting Co. of Canada is approximately \$300,000, according to A. B. Mackenzie, secretary of the Associated Boards of Trade of Eastern British Columbia, who was recently at Spokane. The pay-roll of the smelter at Trail is \$167,000 per month, and \$90,000 is paid to the employees at the company's mines at Rossland, the War Eagle, Centre Star, and Le Roi, the remainder distributed among the workmen in other properties in British Columbia and northern Washington. Although working only six days a week, the Rossland mines are shipping over 25,000 tons of ore per month to the Trail smelter. Sunday closing of the property has become an established custom in the district and is the result of the miners having become permanent residents instead of migratory laborers.

Owing to a shortage of labor at Fernie and Coleman there are no coke ovens and the British Columbia Copper Co. cannot blast in another blast furnace. Up to September the Greenwood mine produced 3,155,578 lb. copper, 8555 oz. gold, and 33,000 lb. silver.

ONTARIO

CORALT. The Royal Commission appointed to investigate labor conditions here has made its report, consisting of one by the majority, E. Coatsworth and E. T. Corkhill; and one by the minority, Joseph Gibbons, for the employees. There were 79 witnesses examined on behalf of employees, and 8 witnesses for the mining companies. There were only two grievances, namely, (1) a demand for more wages, and (2) that employers recognize and confer with a committee appointed by the men. Otherwise the men were satisfied with conditions. In March of this year the Union commenced to talk of higher wages, and in May an increase of 25c. was given to 2800 men, also a bonus of 25c. daily when silver was 70c. or over per ounce. The men wanted all employees to be paid the increase of 25c. It was claimed that the cost of living had advanced 20 to 30%, but the companies admitted only 10%. Owing to the rise in cost of supplies the managers contended that a rise in wages was not justified. The reason why the managers would not confer with the Union committee was because they thought that the Western Federation of Miners was behind the men. The Commission considered that as the committee consisted only of local men it would have been better had the managers met the men. Reviewing all the evidence, the majority on the Commission cannot recommend an increase in wages at present. They realize what the managers have already done, and suggest that the bonus of 25c. be based on silver at 65c. per oz. instead of 70c. The minority on the Commission considers that all employees should have received an increase of 50c. per day; also that as far as the bonus was concerned wages should not be dependent on the fluctuating price of any product, especially when that product has no bearing on the cost of living.

During the year ended August 31, 1916, the Kerr Lake Mining Co. produced 2,433,793 oz. of silver at a cost of 25.25c. per oz. The profit was \$813,702, against \$550,775 in 1915, and dividends paid amounted to \$672,000. The surplus was \$141,072, compared with a deficit of \$69,225. Development covered 4056 ft. Ore reserves contain 3,827,080 oz. of silver, a decrease of 345,320 oz.

POPCINE. At the Dome Lake mine the shaft is down 456 ft. with sinking in progress to 500 ft. A stope above 300 ft. is from 10 to 15 ft. wide, averaging \$30 per ton. The new 200-ton mill is expected to be in operation by October 15.

MEXICO

Men representing the more important mining interests of Mexico are at Atlantic City to appear before the American-Mexican Commission in support of the contention that conditions in Mexico are such as to make practically impossible the resumption of mining operations. The mining committee represented 50 companies, and was composed of influential men. In the first half of 1912 Mexico yielded 33,000,000 oz. silver, 243,000 oz. gold, 74,000 tons copper, 46,000 tons zinc, and 48,000 tons lead. In the first half of 1916 the yield was 6,000,000 oz. silver, 38,000 oz. gold, 23,000 tons copper, 11,000 tons zinc, and 2000 tons of lead. Export taxes on the precious metals are four times heavier than in 1912, while the base metals now have a heavy tax, against none formerly. Forefeitures of property have been forced.

CUSHICUBACIC. Villa men have secured possession of valuable American mining property here, including the San Juan, Cusi-Mexicana, and Cusi Consolidated.

PACHUCA. The United States Smelting, Refining & Mining Co. reports as follows: Earnings for eight months (August partly estimated) after providing for all interest charges on notes, and making usual reserves for depreciation and exploration, are \$6,418,582. The Mexican properties have contributed less than 15% of the total earnings. Conditions in Mexico have improved. The company's American staff, which was withdrawn in June, is now returning.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

HOWARD D. SMITH is at Butte.

DUNCAN MACVICHIE was in San Francisco last week.

BEN. S. REVETT has returned to San Francisco from Colorado.

J. POWER HUTCHINS has arrived in London from Petrograd.

WALTER STRACHE has returned to New York from Greenland.

JOHN G. KIRCHEN, of Tonopah, was in San Francisco last week.

D'ARCY WEATHERBE has gone to Canada, returning from Russia.

THOS. B. STEARNS, of Denver, was in San Francisco last Monday.

RICHARD A. PARKER has returned to Denver from Ludlow, California.

BLANEY STEVENS is at New York; he expects to return to Mexico shortly.

S. E. BRETHERTON is in Colorado; he expects to return to San Francisco about October 24.

MORTON WEBER has been examining the American Girl group of mines at Ogilby, California.

H. C. BELLINGER is in Chile as assistant consulting engineer with the Chile Exploration Co., Chuquicamata.

ARTHUR W. JENKS has been appointed smelter manager for the Burma Mines Corporation at Nantun in Burma.

GEORGE H. UTTER, mine-owner in the Steeple Rock district, Grant county, New Mexico, is visiting in California.

ARTHUR B. FOOTE underwent the operation for appendicitis a few days ago at Grass Valley. He is convalescing satisfactorily.

F. R. VAN CAMPEN, who resigned last spring from the management of the Latouche copper mine, in Alaska, is in San Francisco.

VERNON F. MARSTERS is returning to the United States from San Juanito, Honduras, for a few months' vacation at Rushville, Indiana.

H. J. STANDER, flotation engineer for the Yaryan Resin & Turpentine Co., is at Salt Lake City, on his return from Alaska and British Columbia.

MAX J. WELCH has returned to Los Angeles from Peru, where he has superintended the construction of an experimental concentrator for the Cerro de Pasco company.

JAY P. GRAVES of Spokane, identified with the management of the Granby Consolidated company since its inception, has retired from the directorate. HENRY BRUBEK of New York succeeds him.

BURT B. BREWSTER, for two years Alaskan manager for the Sullivan Machinery Co., has been transferred to Salt Lake City, succeeding H. E. MOON. Mr. Brewster will be succeeded in Alaska by WALTER F. O'BRIEN.

JAMES L. BRUCE, general manager of the Butte & Superior Mining Co., is inspecting mines and smelters of the American Zinc, Lead & Smelting Co., in Tennessee, Missouri, Wisconsin, and Illinois, in connection with the proposed merger of these companies.

Obituary

A. C. HALL, for 16 years with the Guggenheims, died last month at Caldera, Chile.

J. J. BRISTOL died at Reno, Nevada, on August 30, of miner's phthisis contracted during underground work at several large mines of the Rand. Mr. Bristol was a graduate of the University of Nevada, and since 1900 had been in the Transvaal, on the Gold Coast of Africa, and in Alaska.

THE METAL MARKET

METAL PRICES

San Francisco, October 10.

Antimony, cents per pound	9.50
Electrolytic copper, cents per pound	29.25
Pig lead, cents per pound	7.25-8.50
Platinum: soft and hard metal, per ounce	\$90-95
Quicksilver, per flask of 75 lb.	78
Spelter, cents per pound	12
Tin, cents per pound	42
Zinc dust, cents per pound	50

ORE PRICES

San Francisco, October 10.

Chrome, 40% and over, for b. cars California, per ton	13.00-16.00
Magnetite, crude, per ton	8.00
Manganese, 50% (under 35% metal not desired)	11.00 and up
Tungsten, 60% WO ₃ per unit	17.00

The Renfrew mill in northern Ontario is paying as follows for molybdenum ore:

Per cent of MoS ₃	Price per unit
2 to 3	\$13.00
3 to 5	14.00
5 to 10	16.00
10 to 15	17.00
15 to 20	18.00
80, per pound	1.00

Penalties are imposed for bismuth and copper.
A 10% increase on tungsten has been announced at Boulder, Colorado, affecting ore containing from 2 to 10% WO₃.

New York, October 1

Antimony. For 50% ore, immediate delivery, \$1.10 has been paid in the past week.

Molybdenite. It is reported that ferro-alloy makers are using more of this mineral, with the result that inquiries are becoming more numerous. Therefore, there were only one or two buyers. Sales have been made recently at prices ranging from \$1.50 to \$1.75 per lb. of MoS₃ contained.

Tungsten. Several hundred tons of concentrates have been purchased in the past week for 1917 delivery, at about \$17 per unit ton on a profit. In addition, at least 500 tons of ferro-tungsten has been sold for foreign delivery, principally to England. For the bulk of this \$1.60, New York, per pound of contained tungsten was paid, although 20 tons brought \$2.75. It is interesting to note that Great Britain purchased one lot from a company whose name appears on the supplementary blacklist. This may be due to the fact that the British authorities have blacklisted most of the producers and dealers in tungsten and the ferro-alloys.

EASTERN METAL MARKET

(By wire from New York)

October 10. Copper is quieter than in the previous week and is quiet and steady, spotted for order following is the following:

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Oct. 4	68.17
5	67.00
6	68.95
7	68.10
8	68.51
9	68.95
10	67.12
11	67.00
12	67.83

Monthly averages	1914	1915	1916
Jan.	57.58	18.85	66.76
Feb.	57.53	18.15	66.74
Mar.	58.01	17.61	67.89
Apr.	58.79	16.97	64.37
May	58.31	19.87	64.27
June	56.43	19.03	64.01

Gold. New York. American gold, average 100% week ending Oct. 10, 1916, 100.00. London, per cent, 100.00. The following is the quotation for the London Gold Standard, per cent, 100.00.

100% gold, per ton, San Francisco, 100.00. The following is the quotation for the London Gold Standard, per cent, 100.00. The following is the quotation for the London Gold Standard, per cent, 100.00.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Oct. 4	28.50
5	28.62
6	28.75
7	28.75
8 Sunday	28.50
9	28.50
10	28.50

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	14.21	13.60	24.30	July	13.26
Feb.	14.46	13.38	26.62	Aug.	12.34
Mar.	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.02	Oct.	11.10
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	18.75	27.47	Dec.	12.75

Inspiration produced 11,850,000 lb. in September; Miami, 4,381,367 lb.; Anaconda, 29,400,000 lb.; and Shannon, 774,000 lb. The Butte district produced 31,000,000 lb. and Michigan 25,000,000 pounds.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Oct. 4	7.05
5	7.05
6	7.05
7	7.05
8 Sunday	7.05
9	7.05
10	7.05

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
Mar.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.23	7.38	Nov.	3.80
June	3.90	5.75	6.88	Dec.	3.88

On October 20 the Hecla company of Idaho pays 15c. per share, or \$150,000. This makes \$1,250,000 for the current year.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Oct. 4	9.70
5	9.75
6	10.17
7	10.17
8 Sunday	10.17
9	10.17
10	10.00

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.85	19.99	Aug.	4.75
Mar.	5.12	8.10	18.40	Sept.	4.75
Apr.	4.98	9.78	18.62	Oct.	5.16
May	4.91	17.03	16.01	Nov.	5.01
June	4.81	22.20	12.85	Dec.	5.40

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Sept. 12	75.00
19	75.00

Monthly averages	1914	1915	1916
Jan.	29.25	51.90	72.00
Feb.	29.00	60.00	295.00
Mar.	29.00	78.00	219.00
Apr.	29.00	77.50	114.00
May	29.00	77.00	71.70
June	29.00	77.00	71.70

TIN

Prices in New York, in cents per pound.

1914	1915	1916	1914	1915	1916
Jan.	27.87	14.10	11.76	July	31.60
Feb.	29.26	27.32	19.60	Aug.	31.37
Mar.	28.88	18.26	50.70	Sept.	33.10
Apr.	28.90	18.75	41.19	Oct.	30.40
May	27.94	29.88	19.10	Nov.	33.50
June	26.25	19.76	47.07	Dec.	33.60

Tin in London, Oct. 12, 1916, 100.00.

Eastern Metal Market

New York, October 4.

Copper is quieter, but strong.

Zinc has advanced, although buying has been comparatively light. Its strength is based on expectations that the Allies will enter the market for large quantities.

Lead is steady, but quieter.

A big movement in tin is looked for, and already there are indications that the tin-plate mills are considering their requirements.

Antimony is dull and weaker.

Aluminum is strong.

Tungsten ore has been active.

For molybdenite there is a widening market.

A purchase of 200,000 tons of Brazilian manganese ore, is reported. The ore is for delivery over 1917, and contains about 48%. The terms of the sale specify delivery at Rio de Janeiro, the buyer to furnish vessels from that point. At the present freight rate of \$12 per ton, the cost would approximate 75c. per unit f.o.b. cars, Baltimore. Figuring current freight-rates, the transaction would represent an investment of \$6,500,000. It indicates that large interests do not expect the War to end next year, or that any relief is to be expected in the matter of forcing the Dardenelles, or obtaining manganese ore in large quantities from India next year.

The most pleasing feature of the iron and steel markets this past week is the greater activity in pig iron of all grades. With the activity came price advances. So far, foundry iron in particular has lagged far behind other products. Constantly increasing export demand is in large part responsible for the greater activity, although domestic smelters are showing more confidence also. Standard low-phosphorous pig iron, much used for wire, projectiles, and the finer grades of steel, is quoted at \$36 to \$37 per ton, delivered, and \$40 is predicted in the near future. Basic iron, for open-hearth consumption, has also been in heavy demand. The production of pig iron in September was 3,202,366 tons or 106,745 tons per day, against 3,203,713 tons in August or 103,346 tons per day. October opens with 328 furnaces in blast.

The railroads are placing orders for cars, the demand for plates is greater than ever, and a steel famine is freely predicted. August exports of iron and steel totaled 598,192 tons against the previous high record of 540,000 tons in May. There is every indication that tin-plate prices, which have not been fixed for 1917, will be higher.

The scarcity of labor is a common cry.

Steel plates are quoted at 4c., Pittsburg, structural shapes at 2.75c., and bars at 2.75c., premiums being exacted wherever prompt deliveries are wanted.

COPPER

As might well be expected comparative quiet has followed the recent big buying, but with first-hands in an unprecedented position as to the next three-quarters of a year, their quotations are firmly held. For electrolytic, October delivery, up to 29c. is asked, for November 28.50c., for December 28c., for January 27.50c., and for first quarter 27.25c. Lake producers are reported to be sold-up for the remainder of the year. A re-sale lot offered at 29.50c. failed to induce any action this week. For January delivery the Lake producers are asking 27.50c., and for first quarter 27.25c. To a great extent, sales are today a matter of extended negotiations. Companies who have been asked to quote have replied that they had nothing to sell for certain positions, but when they have been approached with a specific proposition they found the metal and sales have resulted. With second-hands prices are a little easier, sales of electrolytic for near-by delivery

having been reported at 28.75c. The electrolytic quotation at London yesterday was £140 against £138 a week previous. The September exports reached the excellent total of 29,803 tons. Stocks in Great Britain and France on October 1 amounted to 5796 tons against 7118 tons on September 15. Including the copper afloat from Chile and Australia, the total European supply on October 1 totaled 10,371 tons, against 11,668 tons two weeks previous. The brass and copper mills continue as busy as ever and are carefully picking what they want from new business offered them.

ZINC

Only spasmodic buying, moderate in the aggregate, has taken place in the past week, but prices have nevertheless advanced, with the result that spot is held around 9.70c., New York, and 9.50c., St. Louis. Last quarter is held at 9.25 to 9.37½c., St. Louis, and first quarter at 9 to 9.12½c., St. Louis. The producers are strong in their belief that the Allies will sooner or later come into the market for large quantities as a concomitant of their recent large purchase of copper. The London market is strong at £52 per ton for spot, the quotation of a week ago. Exports are extremely large, those of September amounting to 14,309 tons, while in the first three days of this month they totaled 1721 tons, 1231 tons of which was shipped to Archangel, Russia. Sheet zinc is unchanged at 15c., f.o.b. mill, carload lots, 8% off for cash.

LEAD

The leading interest continued to quote 7c., New York, and 6.92½c. St. Louis. The New York quotations of the independent producers and sellers have varied from 7 to 7.12½c. Yesterday they asked 7.05c., New York. Some of them are so well sold-up that they are practically out of the market on near-by deliveries. A large amount of lead has been sold in recent days, and it is therefore natural that the market should become quieter. Bullish talk is heard as to the future, although conservative members of the trade believe that a firm steady market is to be expected rather than one of sky-rocket tendencies. The fact is that consumers have pretty well covered their requirements for the remainder of the year. At the same time it is to be recognized that consumption and production are running about even, and if a good foreign demand should develop it will send prices upward. Exports continue on an excellent scale, those of September amounting to 8857 tons. The London quotation for spot yesterday was 5s. higher than a week ago, at £31 15s.

TIN

The feeling is widespread that a good movement in tin is impending. It is believed that buying on September 29 was a forerunner of the expected business, as on that day large tin-plate makers took about 400 tons. More interest is being shown in future positions, and prices are advancing. Spot Straits was quoted yesterday at 39.25c., New York. The September statistics show that deliveries into consumption in that month totaled 5025 tons, of which 675 tons came via Pacific ports. Deliveries since January total 44,413 tons, against 36,905 tons in the same period of 1915. In stock and landing on October 1, was 4769 tons. The quantity afloat, on the 3rd, was 2145 tons.

ANTIMONY

No interest is shown, and prices are sagging. Oriental grades can be had from dealers at 10.25 to 10.50c., duty paid.

ALUMINUM

The market is firm at 62 to 63c. per lb. for No. 1 virgin metal, 98 to 99% pure.

Book Reviews

METHODS IN METALLURGICAL ANALYSIS. By Charles H. White. P. 556. Ill., index. D. Van Nostrand Co., New York, 1915. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.50.

Many books treat of the subject of assaying, and myriads deal with the varied phases of metallurgical analysis, but the one handy volume that presents the best methods of the chemical analysis of all mining and metallurgical products is the above, by one, who for many years has taught that subject in Harvard University. The book is compact and can be slipped into the pocket. It has a substantial binding. The first chapters deal with laboratory equipment and manipulation—most useful to the beginner or for the engineer who is forced to 'brush-up.' The scope of the book may best be realized by a glance at the main headings: Equipment of the laboratory; Sampling; Operation of analysis; Analyses of iron ores, iron and steel, ores of copper and the minor metals, slag, mattes, bullion, alloys; Fire-assaying; Analyses of the cyanide-mill; Analyses of fluxes, fuels, clay, boiler-water; The determination of rare metals; and Tables. The book is not only comprehensive, but it is critical. Every method of analysis described has stood the test of the mill and the smelter. It tells what happens and why it happens, and all pit-falls are plainly marked.—Walter S. Weeks.

EXAMPLES IN ALTERNATING CURRENTS. Vol. I. By F. E. Austin. Second Edition. P. 225. Ill., index. F. E. Austin. Hanover, N. H. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.40.

This book is a reprint of the first edition, to which has been added considerable new material in the form of cuts and subject matter. The aim of the author has been to bring together the theory and practice in alternating currents by presenting problems and showing how they are solved by the application of mathematical formulae. The first 10 pages are devoted to definitions of fundamental units, signs employed in the formulae, trigonometrical functions, and calculus. Then follow the problems; the statement, the data, formulae which apply, and lastly the solution are presented in such a manner as to easily follow each step. The appendix contains a number of tables giving the values of variable quantities used in electrical engineering practice, so arranged as to include a wide range of values and to render evaluation convenient and rapid. To the student the book is valuable in that it trains and guides him in understanding the solution of electrical problems, while to the engineer its chief value is in the carefully tabulated arrangement of mathematical and electrical data.

CENTRIFUGAL PUMPS AND SUCTION DREDGES. By E. W. Sargeant. P. 188. Ill., plans, index. Charles Griffin & Co., London, 1916; J. B. Lippincott Co., Philadelphia. For sale by the MINING AND SCIENTIFIC PRESS. Price \$2.25.

Centrifugal pumps—belt motor, oil engine, or turbine driven—from 1 to 54-in. discharge, are now used in far greater numbers on dredges, for unwatering mines, elevating coal and fine pulp in mills, fire purposes, sewage, and irrigation. Their popularity increases as they are better understood and as improvements in efficiency are made. Although the book deals with English practice the information is useful to Americans, as the former have made good centrifugal pumps for many years. In the United States the metallurgist and the civil engineer have studied the centrifugal considerably, resulting in long-wearing liners and great capacity, especially for high lifts. The multi-stage pump is a great success, the subject being covered in two chapters. Design of the pump and casing

are all-important, this being thoroughly discussed, including pattern making, molding, and machining. For priming a centrifugal several methods are given, also testing its capacity and efficiency. Pipe arrangements and valves are considered. As the rotary air-pump is closely related to the centrifugal it is briefly described. These are used at mines for various purposes. While the pump type of gold dredge is not worked much in America, it is a success in Australia, lifting large quantities of coarse gravel with ease up to 15-in. suction; but in harbors and rivers the suction dredge is operated everywhere, using centrifugal pumps. Here the engineer will find practical notes. Calculations and plans complete a work on an important machine.

PRACTICAL HYDRAULICS. By James Park. P. 284. Ill., charts, plans, index. Charles Griffin & Co., London, 1916; J. B. Lippincott Co., Philadelphia. For sale by MINING AND SCIENTIFIC PRESS. Price, \$1.

The author of this work, who is professor in the University of Otago, at Dunedin, New Zealand, writes on many subjects, including assaying, cyaniding, surveying, and geology. In the South Island of New Zealand the author has many opportunities to study hydraulics, this being a region containing rivers, large ditches, hydraulic mining, and dredging. The volume is termed a text-book for use in mining schools, technical colleges, and for hydraulic engineers. A good deal of the data has been drawn from American sources, and this, together with Australasian and foreign practice, makes a good mixture. Eight chapters cover principles, definition of terms, and the flow of water through orifices, open channels, over weirs, and in rivers; also friction in and discharge of pipes. Construction of dams, ditches, flumes, and pipes is of great importance, as these are subjected to varying pressures, sometimes suddenly abnormal, so examples of well-designed structures are described and shown by working plans. Costs are included. The last chapter covers the subject of water-power and water prime-movers. These include the latest type Pelton wheel and turbines. While American engineers are well versed in hydraulics, they should find something of value in this new book.

LABOR TROUBLES harass the metal-working trades in many parts of the country. Not only is there an inadequate supply, but in some cities housing facilities are not sufficient, and the high rents that are asked are driving mechanics to other places, this being notably true in Detroit. Pittsburg is beginning to suffer from a shortage of freight-cars, which already has cut down shipments. The export buying of steel continues on an enormous scale and premium prices are paid without murmur on foreign account. Manufacturers of steel plates, particularly ship-plates, are submerged with orders. Most of the mills will not consider under 4c., Pittsburg base, for any delivery of tank-plates.

BY MEANS of a process recently invented by Phillip McKenna of the Vanadium Alloys Steel Co., which is operating at Boulder, Colorado, under the name of the Vasco Mining & Milling Co. it is producing ferro-tungsten which the company claims has never as yet been equalled in the high percentage of tungsten content, and low percentage of impurities. The Vanadium Alloys company is now guaranteeing its ferro-tungsten to contain from 70 to 80% tungsten and not over 0.5% carbon or 0.05% silicon. The Vasco company has already shipped 34 tons of 50% concentrate to the Vanadium Alloys at Pittsburg, Penn. (Reams)

A COUNCIL REPORT from Valparaiso, dated September 10, 1916, that is set to newspaper reports the Chile Exploration Co. has sold the copper mining properties of the Compañía Minera de Chuquibambilla for the sum of 7,100,000 Chilean pesos, equivalent to 9 pence exchange to about \$1,280,000 United States currency.

EDITORIAL

T. A. RICKARD, Editor

SCIENTIFIC evidence that the addition of copper to steel and iron increases their resistance to corrosion is a fact that may prove important to the mining industry. We publish a note on the subject.

CALUMET & Hecla is said to be experimenting successfully with flotation, to supplement the Benedict leaching process. No mill-man can afford to neglect the possibilities of flotation. Every mill ought to contain a small machine for making flotation tests.

LABOR is scarce everywhere, but the shortage would disappear if every able-bodied idle man would go to work. While thousands dispute over the length of the working-day, other thousands decide for themselves that no work is best. In an organized community, the shirker should find it as unpleasant during peace as during war.

WHETHER a U-boat or a peace rumor does more to put the soft pedal on a bull campaign on Wall Street, we do not know; but the incidence of either should remind the sagacious man that we live in the midst of uncontrollable factors likely to upset the calculations of the most far-seeing. Many seismic events will happen before we make a return to normal times.

DEMONETIZATION of gold by Great Britain, in the event of the War lasting for another year, is being discussed. The sinister suggestion has grown from a remark in *The Statist* that Great Britain may be compelled to suspend specie payment if her financial resources are stretched too far. The suggestion is one that we do not take seriously, but those at a loss for a topic of conversation may offer guesses as to the world-wide consequences of such a step.

WE note that the Minerals Separation company has insisted successfully on the Miami Copper Company filing a bond for \$250,000 and making monthly reports of the particulars of its flotation operations and the value of the concentrate recovered. This accounting is to be made to the Court at Wilmington, Delaware. Meanwhile the Miami company has filed its appeal to the U. S. Circuit Court of Appeals at Philadelphia. It is announced that the argument of the Hyde case in the Supreme Court of the United States will begin in a few days.

SINCE we published the 'personal' regarding Mr. E. P. Mathewson's resignation and new appointment, in our issue of the 7th instant, the paragraph

about his new work with the British-America Nickel Corporation has appeared in many papers, but usually with an extra 'n' after the word America. We note that the *Anaconda Standard* expresses, in feeling terms, the regret of the people of Montana at Mr. Mathewson's departure from Anaconda. We can understand that. At an early date we shall publish an interview obtained with Mr. Mathewson while he was here recently.

"HIGHEST on record" is a cheerful phrase when it refers to stocks or prices of metals, but it is chilling when it describes the cost of living. According to *The Annalist* index-number of the average price of a number of representative commodities, the cost of living is now 186.84 as compared with 139.72 a year ago. This is a rise of 33.7%. Since the War began the cost of food has risen 59% in England and 107% in Germany. In 20 years the cost of living in the United States has doubled. Perhaps a more significant fact is the doubling of the price of the machine-made pie that has replaced the wholesome comestible of the New England housewife. Peace hath her perils no less than War.

THE success or failure of any mining method depends upon the recognition of its advantages and limitations, and applying it where the conditions are suitable. No system is so elastic as to be applicable in all cases. The first step is to choose the system fitted to the given set of conditions, for on this choice may rest the fate of the entire undertaking. On another page we publish an article, by Mr. E. G. Deane, describing the block method of top-slicing as used by the Miami Copper Company. Like the sub-level caving-system, described in our issue of October 7, it is adapted to large orebodies of uniform grade. It has one advantage not possessed by the sub-level caving-system in that it permits removal and storage of the waste by sorting in the stopes. Almost complete extraction is possible, as the waste of the cap does not mix with the ore. A small amount of preparatory work is necessary and is productive, being done in the ore. When properly carried out there is practically no danger of falls, the timber usually giving ample warning when about to take excessive weight. It is possible to shoot-down a portion of the stope and so relieve the pressure without the necessity of abandoning it. The method is wasteful of timber, as nearly all of it is lost, but since its use is temporary a cheap inferior grade can be utilized. There is considerable handling of timber, which must be hoisted to the stopes from the haulage-levels. Good ventilation is essential, otherwise the temperature

due to the decaying timber in the mat overhead reduces the efficiency of the miners and also increases the danger of fires. Unless the raises are near together in the stopes there is much handling of the ore. A chute interval of 50-ft. centres seems to be too large, necessitating a great deal of work by the shovelers in loading and wheeling the ore to the chutes. The complete extraction of the ore possible by this method equalizes the higher cost due to loss of timber and the increased amount of handling that is necessary. A production of 10 tons per man-shift at an estimated cost of only 88 cents per ton speaks for itself.

MEXICAN affairs are discussed by our Special Correspondent under the heading of 'Review of Mining.' Those interested in the subject will find both information and comment of a timely kind. An abstract of recent decrees issued by the Carranzista government will be useful for reference. The tripling of the export tax on metals is noteworthy. The new taxation of mineral land is not unreasonable. On the other hand, the renouncement of diplomatic protection is ominous; the decree is unnecessary if Carranza intends to treat the foreigner fairly. Our correspondent discusses this point lucidly. 'Mexico for the Mexicans' is a slogan to which none of us could object if our nationals had not been invited by successive Mexican governments to give a hand in developing the industrial resources of the country and if our nationals in so doing had not been guaranteed protection. That is a point entirely disregarded both at Mexico City and at Washington as Mrs. O'Shaughnessy spells the seat of administration. Among his other pronouncements, Señor Carranza has interdicted bullfighting. This is commendable, but the slaughter of bulls might be ignored just now in face of the assassination of human beings to which the warring factions are committed. Despite the unsettled political conditions the American managers of mines are returning to Mexico with a view to resuming operations. The optimism of the mining engineer is unconquerable. On the whole, the news concerning conditions in Mexico has been encouraging recently, so that resumption of mining is recorded at many points, notably Pachuca, El Oro, Guadalajara, and along the West Coast. Meanwhile the Joint Commission continues in session at Atlantic City and is likely to remain in active conversation until after the presidential election.

DISCUSSION this week is enriched by letters from widely separated sources. Mr. W. E. Thorne, a Californian engineer, writes from Siberia to correct sundry details in a recent description of alluvial mining methods on the Lena goldfield. Mr. L. J. Hohl draws the pen in defence of Mr. Shockley. When Mr. Hohl wrote his letter he was quite unaware of the action being taken by the local section of the Institute, although subsequently he attended the meeting at which that action was ratified. His letter is amusing in showing how ineffective was the censoring of Mr. Shockley's paper, for

the statements to which objection was taken are to be found in figures or by inference in the paper as it now appears in the proceedings of the Engineering Congress. The quotation of George F. Baer's celebrated saying was bound to be made by somebody during the discussion of this episode and we are glad that Mr. Hohl should have taken pains to quote it accurately. The letter from a prospector will commend itself as the record of a bit of personal experience. Major Karri Davies will be known to any reader familiar with the history of South Africa. We welcome his comment on our recent editorial and acknowledge the slip made in our statement of the ratio of productive to unproductive ground in the Far East Rand. The suggestion for a method of adjusting the deduction of the Government's share of profit without penalizing efficiency is well worthy of consideration. Our friend Mr. Thomas T. Read has settled the spelling of McDougall, as applied to the furnace of that name. 'McDougall' it shall be henceforth. The letter from Mr. George E. Collins supports the Everson tradition and includes an interesting suggestion. The real point is that Everson, whether the lady or her husband does not matter, obtained a patent for a process that was never worked successfully and was, we believe, unworkable. The Ethore brothers devised a process that was used in a mill and served as the beginning for a revolution in metallurgy.

A Matter of Principle

On another page we publish a protest made by Mr. William H. Shockley against the censoring of a paper presented by him to the International Engineering Congress last year. He protests, not so much against the censoring of his paper by the publication committee of the Congress, but against the interference of the board of directors of the American Institute of Mining Engineers, acting upon the peremptory demand of the Anthracite Section of the Institute. We refer the readers to the facts as stated by Mr. Shockley. His statement is plain and reasonable. For those that do not know him personally we may say that he is a mining engineer of wide experience and ripe knowledge; he has shown good temper and no small amount of courtesy throughout the episode; in every respect he is a worthy representative of the profession and entitled to the consideration that any one of us has the right to demand. In the first instance, he was requested to prepare a paper on the economics and sociology of mining; the request was made by Mr. H. Foster Bain, at that time a member of the management committee of the Congress. Mr. H. C. Hoover had been expected to write a paper on this particular subject, and when he was unable to do so, owing to his great work in Belgium, the task was delegated to Mr. Shockley, who, in agreeing to write the paper informed Mr. Bain how he expected to treat the subject. Mr. Bain knew Mr. Shockley well and was aware of his radical views. Nevertheless Mr. Bain officially urged

Mr. Shockley to prepare the paper. He did so. The paper was passed by the editors and accepted by the publication committee of the Congress; it was printed and circulated by the Congress. At the meeting of the Congress in September 1915, Mr. Shockley read an abstract of his paper and on that occasion one or two of the anthracite engineers objected to some of his statements. The discussion was cut short by lack of time. Subsequently Messrs. Edwin Ludlow and R. V. Norris, of the Anthracite Section at Wilkes-Barre, Pennsylvania, called upon Mr. Shockley to withdraw some of the statements in his paper. He demurred to doing so, suggesting that they contribute to the discussion and present their own view of the question in dispute. After some correspondence between the parties to the controversy, Mr. Shockley made sundry changes, which did not suit the anthracite engineers. Finally on June 11 a telegram, quoted in full in Mr. Shockley's protest, was addressed to the Chairman of the Congress at San Francisco, insisting that all reference to the anthracite region "be expunged from the paper by order of the directors of the Anthracite Section of the American Institute of Mining Engineers." When this imperious dispatch was received by the Secretary of the Congress he called a meeting of representative mining engineers and officials of the Congress. Those present at the meeting resolved unanimously that the tone of the telegram was most objectionable and that the Chairman of the Congress, then at Brooklyn, be advised to publish Mr. Shockley's paper as already amended. On June 23 the directors of the American Institute of Mining Engineers voted that unless Mr. Shockley's paper was changed to meet the views of the Anthracite Section, it should not be published. A copy of this resolution was sent to the Chairman of the Engineering Congress. He, meanwhile, had ignored the expression of opinion voiced by the committee called by the Secretary on June 12 and was now inclined to waive his rights. The offices of the Congress were being maintained pending the settlement of the dispute, causing expense and worry, whereupon Mr. Shockley cut the matter short by agreeing to omit the remarks to which objection had been made by the Anthracite Section, replacing them by an explanatory note. When the facts of the case became known, the matter was brought before the San Francisco Section of the Institute, a feeling of resentment against the injustice done to Mr. Shockley was freely expressed, and on October 10 a resolution was carried unanimously stating *inter alia* that "the action of the directors of the American Institute of Mining Engineers in censoring the publication of Mr. Shockley's paper is unwarrantable." That is the story to date. It is not a pleasant one. Mr. Shockley expressed no opinion of his own concerning the conditions prevailing in the anthracite region, he said only that if the wages were so much and the cost of living so much, then it was probable that a number of heads of families were inadequately paid. He quoted figures from the U. S. Immigration Commission and from a report of the State of Pennsylvania. If the gentlemen at

Wilkes-Barre did not like it, they were at liberty to refute Mr. Shockley in the usual way, by contributing their opinions to the discussion of his paper. They had no right to demand the deletion of the paragraphs that did not please them and they were not warranted, we submit, in calling upon the directors of the Institute to take drastic action. As for the directors, their action is indefensible. By what right did they dictate to the Engineering Congress what it should or should not publish? It is true the Institute was one of the five technical societies that contributed to the underwriting of the Congress, but did that give them the privilege of editor or censor? As for the Congress management, it acted weakly and ingloriously in surrendering its responsibility to the clamor of a coterie of excellent gentlemen representing the one great natural monopoly in the United States. What a bungle they, and the others supporting them, made of their censoring is shown admirably in the letter from Mr. L. J. Hohl, appearing under 'Discussion.' Similarly in a discussion of the Panama Canal before the Congress sundry thoughtful criticisms were presented in discussion by Mr. C. E. Grunsky, a veteran engineer and member of a Government Canal Commission, and because his remarks did not suit the powers that be, he was asked to withdraw them, and on his failure to do so, the Committee of Management passed a resolution withdrawing all the discussion from publication, although it had been announced officially, in notices to the engineering profession, that "written discussions would be welcomed in any language." Some people appear to be mighty particular about the language! We do not believe in the suppression of honest criticism; we believe that suppression prevents the creation of a healthy public opinion; in the end it hurts those criticized much more than a frank ventilation of conflicting ideas. But the most objectionable feature of the episode is the action of the directors of the Institute in issuing a ukase against one of its own members and against inferences expressed by him not in the transactions of the Institute but in the proceedings of another organization. This is an interference with the liberty of the professional man and it is not to be tolerated.

The Decadence of the Rand

The mining industry of the Rand is a subject interesting to the American mining engineer for many reasons, to which a new one has been added by the possibility of American capital participating as a separate unit in the exploitation of this, the greatest goldfield in the world. Our readers are aware that an American syndicate, headed by the Messrs. Lewisohn, sent an expeditionary force of engineers to Johannesburg in the early part of this year to investigate the chance of profitable business, more particularly in that part of the goldfield called the Far East Rand. Whether anything is to come from this incursion of American enterprise we do not know, but the fact that it has been made affords an excuse for com-

menting on Rand affairs from the American point of view. We shall be frank, believing that in frankness lies the best possibility of being useful.

The business of the Rand, that is, the flotation, financing, and management of the gold mines, is in the hands of the so-called groups, financial organizations founded in the early days by individual operators of great initiative and resourcefulness. These 'big houses,' as they are also called, appear to work under a tacit agreement not to trespass upon each other's preserves; no group has wrested the control or management of mines from another group; even in the case of a fiasco like that of the East Rand Proprietary there were no signs of an attempt to take advantage of the weakness of the old directorate. It is true the Central Mining people obtained the direction of affairs in place of the Farrars, but the Central Mining had a large block of stock in the company and protected the late Sir George Farrar so as to save his face and leave him in his position of chairman. Sir Joseph Robinson has played a lone hand and cannot be included in the pact, but he also has not attempted to wrest control from any other group, nor they from him. At the time of the tenders for the Government Areas the Barnatos were not included in the general group agreement as to the Far East Rand exploitation, so that their solitary action in tendering was likewise no infraction of the general understanding to which we have referred. Such an understanding may simplify life for those in control but it is not calculated to promote the best interests of the industry. Signs are not wanting that a complacent disposition over past performances is tending to technical stagnation. The infusion of fresh blood might restore the spirit of youthfulness to an industry prematurely venerable. The personnel of the companies has lost distinction, it is composed mainly of men of local origin and training, the result of continuous promotion from the ranks, diminishing the chance of such diversified experience as is essential to any successful departure from the beaten track. The introduction of new methods, aimed to lower the cost of exploitation, would be more likely if advantage were taken of the recent knowledge obtained in low-grade copper mining in Arizona and in the large scale working of such gold deposits as those of Jumeau, where new records for low cost have been made during the last two or three years. We recognize the growth of a feeling of national solidarity or exclusiveness, according to the point of view, engendered by the War and the consequent desire to have the resources of the British empire developed by British capital, but an American may be permitted to smile at the attitude of the naturalized German Jew element, which is more British than the British in the expressed wish to exclude aliens. The Germans in the Transvaal need to make no apology, they have played an honorable part in the development of the Rand and their retirement during the Great Unpleasantness left the non-national German Jew to pose, as an imperialist of 21 carat purity. A number of these have been promoted to authority under the group system establishing an an-

cracy that has stifled the initiative and character essential to any great accomplishment. The big men that made the Rand—Alfred Beit, Julius Wernher, J. B. Taylor, Cecil Rhodes, George Farrar, Hermann Eckstein, and the like—have been succeeded by men who were mostly clerks in their service, without technical education or knowledge of mining outside the Rand. The groups are no longer the real owners of the mines but controllers by virtue of proxies, with the result that the share-dealing part of the business has been magnified at the expense of the exploratory and development phases of the operations. The coterie of office-holders now controlling the industry from London lacks the authority to delegate initiative to their representatives at Johannesburg, and this in turn detracts from the usefulness of the engineer and of the manager at the mine. A miasma of indirection afflicts the entire system. One result is to side-step the problem of native labor. The observant visitor agrees with the enlightened Boer that the best results are not being obtained from the Kaffir, because his capacity is restricted arbitrarily by an artificial barrier. For example, the native is not permitted to use an explosive, to serve as station or skip-tender, or to handle a winch in which men are raised and lowered. In other mining districts such tasks are performed safely by Koreans, Mexican Indians, and negroes of every shade. The white-labor union is allowed to dominate the economic conditions; the native is not permitted to advance according to the proof of his intelligence nor is he accorded full scope for the ability developed by training. The white man plays the part of an expensive supervisor. The economic waste is undeniable. Pay in proportion to efficiency would promote skill and the raising of wages would increase the wants of the native so as to prompt him to remain at work. These are observations established by experience in every part of the world where the indigenous population has been harnessed to industry. Just now there is an abundant supply of native labor on the Rand and it is being used lavishly under a diminished white supervision. In this and other matters the mines suffer from politics. Several of the leading operators are prominent in parliamentary affairs, in opposition to a violent Labor party, creating bitter antagonisms not at all good for the welfare of the South African Union. The Chamber of Mines itself is semi-political and the newspapers are under control of the groups, the general result being prejudicial to the maintenance of a healthy state of public opinion or of an atmosphere in which useful criticism can live. The Rand needs new capital, which the present groups are not competent to furnish; it needs new ideas in technology, which those bred in the locality are unlikely to conceive. By aid of one and the other it should be possible to accomplish a good deal; for instance, reduce the cost to 10 shillings per ton and thereby extend the resources of the goldfield not only by finding new ore but by widening the margin of profit to be gained from the ore already proved; in other words, give a new lease of life to the Rand.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Lena Goldfield

The Editor:

Sir—In your concentrates of April 15, 1916, the statement appears that "trommels and *kulibinas* washing-machines at the Lena gravel mine, Siberia, have been replaced by the long sluices of the Alaska type, resulting in less loss of gold and lower cost, 56 to 35 cents per cubic yard."

This is incorrect. The long sluices were tried with parallel T-rail rifles, but most of them have been discarded, because they were losing more gold than the other type of rifle. The parallel is o.k. for suitable material and capacity, but for such material as we have here they are not suitable. The gravel is subangular, with some clay, therefore the Hungarian type of rifle is better with frequent drops of a few inches in the sluice.

The reduced cost per cubic yard is from the winter-washing plants; a good part of the gravel goes direct to the sluice from the mine, and is not thrown on the winter dump to be re-handled, as was the former practice. These winter-washing plants were recommended by Leon Perret, general manager in 1913-'14, a Russian mining engineer; they were installed by R. E. Smith, an American.

W. E. THORNE.

Bodaibo, Siberia, August 4.

A Matter of Principle

The Editor:

Sir—A few days ago I received my copy of 'Transactions of the International Engineering Congress 1915—Mining Engineering' and found on page 17 ('The Economic and Social Influence of Mining with Special Reference to the United States,' by William H. Shockley) the following foot-note by the author.

"The writing of this paper was completed in June 1915, and when presented at the meeting of the International Engineering Congress in September 1915, it contained statistics, drawn chiefly from Vol. 16 of the Immigration Commission Reports, which seemed to show that the pay of the anthracite miners in Pennsylvania was less than the amount required for physically efficient living. These statistics were claimed to be erroneous by the Anthracite Section of the American Institute of Mining Engineers, and the Section asked that they be omitted. The same request was also made by the American Institute of Mining Engineers.

"In view of the fact that since the paper was written

the wages of the anthracite miners have been materially increased and their hours of labor reduced to eight, daily, and therefore their living conditions have been improved, and, furthermore, in order to avoid controversy in the transactions of this Congress, the author has consented to omit these statistics and his remarks, indicated by asterisks on this and subsequent pages, relating to the anthracite miners' wages. This step is taken by the author in deference to the request of the Committee of Management of the Congress and without prejudice to his own views in the matter."

During the great strike in the anthracite region in 1902 George F. Baer, the head of the coal trust was quoted as stating: "The rights and interests of the laboring man will be protected and cared for, not by labor and agitation, but by the Christian men to whom God in his infinite wisdom has given control of the property interests of the country." Mr. Baer, I understand, is dead, but evidently "his soul goes marching on."

The censor however has not done very efficient work. While he has eliminated from the report the statement of average yearly earnings of the miners in Pennsylvania, he has permitted those data for the State of Indiana to remain; these show that the average annual earnings vary from \$499.61 to \$737.27, leaving the reader to infer that the wages for Pennsylvania must have been much lower. He has further permitted a statement showing the cost of living at Johnstown, Pa., to be \$780 per annum. This latter statement is on page 20 and immediately following it we find the ominous line of asterisks.

And finally on pages 42 and 43, we find the following statement:

"According to the mine operators' statement, these miners (Southern Colorado) are making the highest wages of any coal miners in the United States; the annual wages for all miners in the Victor American Fuel Co. for the year ending June 30, 1913, were \$1100.75; for the same period the miners of the Colorado Fuel & Iron Co. made \$999.36; the average being more than twice that of the anthracite miners of Pennsylvania."

Thus we surmise, that the annual wages of the anthracite miner must be considerably less than \$500 per annum, and admitting that they have been increased, it is not to be presumed that the increase has reached the sum of \$780 per annum, the cost of living.

But the point I wish to make is one of principle. Even assuming that the statistics cited by the author were wrong and misleading, the suppression of them is un-

warranted and the plea that controversy might ensue evades the issue.

Controversy is much more likely to ensue from suppressed data, which leave the door open to all kind of surmises; moreover if the figures were erroneous, as claimed, the author of the paper would certainly not have offered any objections to the publication in a footnote of the figures claimed to be correct, showing, as he has done, the source of information.

As the matter stands, Mr. Shockley's footnote reads very much like the famous recantation of Galileo and its closing paragraph recalls his "*E pur si muove.*"

L. J. HONL.

San Francisco, October 9.

[This subject is discussed in our editorial columns.—Editor.]

Prospecting

The Editor:

Sir—Under 'Prospecting,' Mr. Sharpless says he would like to read an experience or two; so I donate one. Some 15 years ago, I was 30 years old, single, worth \$5 per day around a mine, had worked as assayer, shift-boss, foreman, etc., knew ore when I saw it, and fairly honest and reliable. This I mention rather to impress the fact that there are many such. I was tired of working for wages six months or so, then a new suit of clothes and a bright red interval, and then another grind. I figured that by putting in a year or two prospecting, I would do better; so made the following offer to some business men, friends of mine:

I would contract to prospect for six months to two years; to supply my own outfit and pay all expenses; to receive one-half of any discovery and one-half wages, or \$2.50 daily; or one-fourth interest and three-fourths wages. I figured that this was perfectly fair; and if we had no luck, at least I would have a few dollars at the end of the period to turn around with. My friends turned this down cold, saying that they could get plenty of men willing to go prospecting for \$10 to \$15 a month and one-half of any find. I looked around the town and saw that they were right, there were plenty of hobos who were only too glad of a month's hand out all in a bunch. The more I studied the question, the more I was convinced that there was something wrong. I, of course, knew that my offer was perfectly fair, but I also knew that those friends of mine were good business men; so I decided to go after the question differently. I picked out a known mineralized section and camped right there for wages at \$5 per day; of a Sunday I would look around, would listen to the prospectors, spend a few dollars for assays and so on. At last I got hold of a promising looking property; no partners, whatever. Every month so much wages would go to development; and this was much more fun than looking forward to the new suit of clothes.

I got married and began to find that \$5 per day was a whole lot more money than I had ever imagined. I leased the mine, as we had struck ore, and now it is

bringing me in a little money; with the good chance of making a valuable property. I will mention that in the ordinary course of things, I became acquainted with several mining engineers and geologists, who looked over my property and gave me some valuable advice, charging me absolutely nothing. They did this purely for friendship's sake; and I am certain that any of them will do this for a prospector if his mine is not too far out of their road, and weather permitting.

Now, suppose that a man wishing to invest money prospecting, in place of looking up and grubstaking someone, should proceed in the following manner: Pick out a district which he favors; look up the engineers who have practised there; ask one of them if he has not seen some promising prospects or prospectors in that locality; or perhaps a mine too small for a large company, but still a good little mine. What will this engineer charge for this valuable information or will he answer at all?

I venture the guess that he will give a rough outline of the camp freely, charging nothing; an exchange of cards perhaps; for the rest—the human equation.

PROSPECTOR.

Nacozari, September 21.

Gold Mining in South Africa

The Editor:

Sir—When a mining district has produced over two and a quarter billions worth of gold, paid enormous dividends, and is today producing over fifteen million dollars per month, it is surely worthy of careful consideration on the part of Americans. More especially when it is known that this amount has been produced from 40 square miles of conglomerate and that there is still five times as much of the same formation of gold-bearing rock to be explored and developed.

Having lived in South Africa for twenty years, and still owning interests there, you will understand the pleasure your editorial on 'The Far East Rand' (in your issue of October 7) has given me, and no doubt many others. A long acquaintance with the Government Mining Engineer enables me to cordially endorse your remark that "he is thoroughly capable and fair-minded." He is also the last man to place an embargo on efficiency.

Mr. Kotze in his recent report on the Far East Rand is aiming to make a provision whereby any company working this Government-owned ground will receive the full benefit they are entitled to by their skill and ability in reducing the working and developing costs of normal times.

The only way which suggests itself to me for this being done is for Mr. Kotze to arrive at a standard working cost per ton milled and a standard development cost based on today's, or normal time, prices. With the data he has at his disposal, together with the consistent conditions of mining he has to deal with in this case, this should not be so difficult. When these figures are fixed, it should not be hard as far as working and develop-

ment costs are concerned) to determine the Government's proportion of profit, based on these standard costs, although it might involve a tonnage calculation, which should not offer an insurmountable difficulty. By this method, the Government would get the advantage of the full value of the ore and the company the full advantage of any reduction in working costs below today's, or normal times, which they would be entitled to from any improved method of working they might introduce. An additional indirect advantage to the country, which is more far-reaching than the exaction of a high royalty, would be the reduction of working costs, thereby permitting much lower-grade ore to be mined throughout South Africa.

If working costs today could be brought down to \$2.50, instead of \$4.50 per ton, South Africa would benefit, because more people would be employed in the mining industry; the revenue from the Government-owned railways, as well as from the customs, would be increased. The needs of a larger population will stimulate agricultural development. So it may be taken for granted that Mr. Kotze and the Government will do everything in their power with this object in view and will favor rewarding and not penalizing efficient management, recognizing that by adopting this policy the Government will assist in bringing about the working of larger areas that are today unprofitable.

For the benefit of those who are not conversant with South African mining law, it might be as well to state that in the Transvaal a mine is worked out when all the ore within and under the four sides of a property is exhausted; it does not mean that the lode has come to an end. All that has happened is that the same lode is being worked, only by a different owner, on the adjoining property. The apex law does not apply in the Transvaal, although it does in Rhodesia.

On the scheme of finance, I agree with you; the present proposal seems a little like placing the cart before the horse. Certainly, the big risk is taken when your fortune-hunting shaft starts on the long expensive journey in search of the deep-level lode of the Far East Rand. If when the shaft meets the fickle Jade she is found to be good and attractive, there is little risk, and one can expect that all will go well and prosper for ever after.

Your statement that Mr. Kotze takes 60% as being the productive area should read 40% productive, and 60% unproductive, as an average, the ground so far having been 15 to 85% profitably productive, but he points out that in some cases this will prove too optimistic or too drastic, whichever the case may be.

The exploitation of the claims in the Far East Rand, favorably situated, although requiring a large amount of money, involves little speculative risk, especially true when the areas are sufficiently large and compact. As in all mines, there are rich and lean areas. In the case of the Far East Rand, the success attained by the mines that have produced \$215,000,000, up to the end of 1915, from 26,682,000 tons of ore milled, ensures

confidence and establishes this part of the Rand as safe and sound for the investment of capital in mining ventures.

W. KARRI DAVIES.

San Francisco, October 10.

The McDougall Furnace

The Editor:

Sir—In your issue of September 9, you are good enough to include me in a list of authorities on the spelling of Arthur McDougall's name. Regretfully I must deny the soft impeachment. The authority for the spelling used in my 'Recent Copper Smelting' was the proof-reader, who injected a ray of decision into the fog of uncertainty by asserting that the matter had been carefully gone into by someone some years before and thus decided. You have, by the way, overlooked a fourth variant, M'Dougall, used in the *Encyclopædia Britannica*.

Now that you have re-opened the question, I have been interested to secure more definite authority and have consulted the records of the British Patent-Office. I find that on January 25, 1868, patent No. 270 was issued to Arthur McDougall, of the firm of McDougall Bros. of Manchester and London, for his "apparatus for burning, calcining, or roasting sulphur, ores, or other materials." British patent specifications do not give a facsimile of the signature, as those in this country do, but it is probably safe to assume that the spelling there given is correct.

The application and its accompanying drawings show a furnace, 6 ft. in diameter, essentially identical with the present form, with the exception that only one hearth was used, heated from beneath by a fire-box. McDougall specifies that if one hearth is not enough, others may be superimposed on the first. No mention is made of any provision for cooling the cast-iron rabble-arms, and this defect led to its failure in practice. In the 1879 edition of Lunge's 'Sulphuric Acid and Alkali,' the author says that the McDougall furnace is theoretically the most perfect for burning pyrite 'smalls,' but that it was unsuccessful because of the difficulty in replacing the rabble-arms and because it made so much dust as seriously to contaminate the acid in the chambers. Apparently it never came into favor in Europe, and not until J. B. F. Herreshoff designed a furnace in which the rabble-arms were separable from the central shaft was it successful in America for burning pyrite. Small furnaces, 10 ft. 10 in. diameter, only roasting five or six tons per day, were used for roasting copper ore in the Heinze smelter at Butte. In 1898 Frank Klepetko built a 16-ft. Herreshoff furnace at Great Falls. This was a 40-ton furnace, with an air-cooled central shaft and solid arms, and the increased size and rate of driving naturally made it run so hot that the rabble-arms became warped and distorted. Both air and water-cooling of the arms was considered, but Mr. Klepetko's judgment was that the latter was preferable, so this furnace was

shut-down and re-built into the Klepetko-Evans furnace, with water-cooled central shaft and rabble-arms. More recently Utley Wedge has perfected the use of an air-cooled shaft and rabble-arms. These three types are really only modifications of McDougall's idea, and it is interesting to note that his patent claims cover "a self-acting rake or stirrer arranged, combined, and operating substantially as hereinbefore described," and also "the general combination and arrangement * * * as described and illustrated." Presumably he never made any money out of his patent, and it would seem, in view of the general use of his type of furnace for roasting copper ore and pyrite, that the least we can do for him is to spell his name correctly.

If you are in the mood for straightening out the Maes, you might also come to the rescue of Mr. Macquisten, whose tube concentrator is frequently referred to as the MacQuiston tube, or some other variant of his name.

THOMAS T. READ.

New York, September 21

Elmore and Flotation

The Editor:

Sir: I have read with much interest Mr. A. Stanley Elmore's article in your issue of September 24.

I should be the last to depreciate the share which the Messrs. Elmore have had in the development of the art of flotation. Few will deny that their contribution has been greater than that of any other individuals; and that it has received inadequate recognition, both morally and financially.

Inventors are prone to think that their particular addition to the world's stock of knowledge was the real starting-point of all progress. But when Mr. Elmore claims his brother's first patent (doubtless an independent invention, although so much later than Everson's), involving the incorporation of oil into an ordinary mill-pulp, to have been the actual beginning of oil-flotation, he makes a claim that, in my opinion, is unwarranted. It is perfectly true that the first Everson patent provided first for mixing dry ore with acid, oil, and a small quantity of water, and subsequently washing the oiled pulp in a large quantity. Dr. Everson, the inventor, was a physician, and naturally used the physician's way of mixing, by first using sufficient water to make into a paste, and adding the bulk of the water subsequently. This however is a mere matter of manipulation; which might have been, and probably was, modified when the inventor came to Colorado and saw that in actual mills the ore and water came to hand ready mixed for use. Dr. Everson's final method of manipulation on a laboratory scale, according to the recollection of persons still living, seems to have involved the use of a large glass jar fitted with an egg beater for agitation of the ore, oil, and water, and also with a glass tube for introduction of air.

Here we have the germ; to my mind all later developments were such as would, in actual operation, naturally follow from it. They are, to quote from Mr. Elmore,

"in the nature of ordinary development of working details." For all that, they have made all the difference between success and failure.

GEORGE E. COLLINS.

Denver, October 2.

The Mexican Commission

In a memorandum submitted to American members of the American-Mexican Commission by the conference of American-Mexican mining and smelting interests, of which William Loch, Jr., of American Smelting & Refining Co. was chairman, it was stated that 45 companies concerned have sustained a loss in depreciation of property in Mexico and actual wastage of more than \$7,246,031 in the years of idleness. Upward of \$16,088,363 has been lost in wages alone to the Mexican people. The mining and smelting industry conducted by Americans in Mexico is practically at a standstill. This is shown by number of employees, pay-rolls, and metal production for first half of this year compared with the year 1912, taken as the last normal year. The 45 companies' cash investment in properties is \$125,000,722, with plants in 14 states:

	First half of 1916	Year 1912
Aggregate pay-rolls (U. S. currency).....	\$3,671,302	\$18,726,090
Number of Mexicans employed.....	6,000	62,216
Copper matte or bullion, tons.....	23,156	74,984
Zinc ore, tons.....	11,183	46,765
Lead bullion, tons.....	2,928	70,929
Silver, ounces.....	6,200,339	31,892,735
Gold, ounces.....	39,895	252,843

The burden of new taxes is shown by the following comparison between taxation on basis of rates and laws promulgated under the constitution and in force in 1912, and actual and estimated effect of rates promulgated by the *de facto* Government, based on production occurring in 1912, for the 45 companies:

	Constitutional law, 1912	Arbitrary decree, 1916
Pertenencia.....	\$96,629	\$569,738
Export and all other taxes.....	1,629,971	7,096,052
Total.....	\$1,726,600	\$7,665,790

Under existing tax decrees, companies mining and treating large tonnages of low-grade ores, which constitute the most extensive mining operations in Mexico, will be unable to resume operations, since export taxes on the metal, which in the new rates are shown as 10% and 5%, often work out as high as 50%. This is so because no allowance is made for cost of transportation, treatment, and marketing. *Boston News Bureau.*

CHROMIUM production of New Caledonia, near Australia, was 19,216 metric tons in the first quarter of 1916. This sells for \$9 per ton in London, 50% Cr₂O₃ content.

PLATINUM has been discovered in the Sierra la Ronda, southern Spain, and the average of 50 drill-holes was 3 grains per cubic metre, or 31 grains per cubic yard.

The American Institute of Mining Engineers as Censor—A Protest

By W. H. Shockley

On page 17 of the volume on mining in the transactions of the International Engineering Congress and in my article on 'The Economic and Social Influence of Mining' will be found the following note:

"The writing of this paper was completed in June 1915, and when it was presented at the meeting of the International Engineering Congress, in September 1915, it contained statistics, drawn chiefly from volume 16 of the Immigration Commission reports, which seemed to show that the pay of the anthracite miners in Pennsylvania was less than the amount required for physically efficient living. These statistics were claimed to be erroneous by the Anthracite Section of the American Institute of Mining Engineers and the Section asked that they be omitted. The same request was also made by the American Institute of Mining Engineers.

"In view of the fact that since the paper was written the wages of the anthracite miners have been materially increased and their hours of labor reduced to eight, daily, and, furthermore in order to avoid controversy in the transactions of this Congress, the author has consented to omit these statistics and his remarks, indicated by asterisks on this and subsequent pages, relating to the anthracite miners' wages. This step is taken by the author in deference to the request of the Committee of Management of the Congress and without prejudice to his own views in the matter."

Herewith are the remarks that were omitted:

"PENNSYLVANIA ANTHRACITE REGION

		Average yearly earnings
16 heads of families, native born.....	(23)	\$732.00
416 heads of families, foreign born.....	(23)	447.00
432 average of both of the above.....	(23)	457.00
99.6% of the 969 employees 18 years and over earn less than		1,000.00
43,201 contract miners	(99)	728.84
33,292 miners, laborers	(99)	495.92
48,024 other inside men	(99)	541.23
29,554 outside workmen	(99)	526.88
16,238 breaker employees	(99)	358.17
(23) Immigration Commission Report, Vol. 16.		
(99) Anthracite. Scott Nearing, page 101.		

"In the table of the wages of the miners on page 19 it will be noted that the general average of 432 heads of families in the anthracite region is given as \$457; this figure is from the report of the Immigration Commission (23); the data for that report were probably collected in 1908-1909; since then there has been a 10% advance in wages (in 1912), and hence this average of \$457 should now be \$503. The other statistics relating to the anthracite region are from the report of the Secretary of In-

ternal Affairs for the State of Pennsylvania for 1912 (99); the average of the whole 170,309 mentioned by him is \$560.02, which is not vitally different from the average of \$503 already given. Judging from the statements of many investigators of the cost of living, it should require from \$700 to \$780 to support a family properly in the anthracite region. Hence, it seems probable that a number of the 432 heads of families whose annual earnings average but \$503 cannot support their families properly—that is, their wages are inadequate.

"The statement in regard to wages made by the Immigration Commission and the inference from the rate of wages and the probable cost of living that the pay of the anthracite miner is inadequate are denied by the anthracite mine operators, who state (100)* "It is a well-known fact that as an average there is not a more physically fit community in the United States than that composed of the anthracite miners. The anthracite operators further state that the average wages are now (1915) much higher than those given by the Immigration Commission; they point out that the Anthracite Strike Commission found that the wages of the contract miners of the Lehigh Coal & Navigation Company were \$738.84 and that all the underground employees of the same company earned \$519.20; this was in 1901; since that date advances in wages have been made, and allowing for these advances and assuming that the same number of days have been worked, the wages of the contract miners would now be \$894 and the wages of the underground employees \$628. Unfortunately, the anthracite operators make no statement as to the nationality of the employees or as to their marital condition, therefore no direct comparison can be made between the figures of the operators and those of the Immigration Commission.

"But, whatever conclusion the student may come to as regards the sufficiency of the pay of the anthracite coal-miner, there is no doubt that many of our workmen are poorly paid; this inadequate pay of the workmen exists in many industries and is said to be largely due to the lower standard of living of the 'new immigrants'."

As stated in the note above quoted, these remarks were omitted in deference to the request of the Committee of Management of the International Engineering Congress, this request having been prompted by the following resolution of the directors of the American Institute of Mining Engineers, passed at New York on June 23, 1916.

"Voted that it is the sense of this meeting that if the paper of W. H. Shockley to the International Engineering-

* (100) Letter from E. W. Parker, Director Anthracite Bureau of Information, to R. V. Norris, Chairman of Anthracite Section, A. I. M. E., Oct. 13, 1915.

ing Congress which has been objected to cannot be changed to meet the views of the Pennsylvania Anthracite Section, it should not be published."

In a letter to the Secretary of the Institute, on February 24, 1916, I pointed out that my statements were statistics from the official reports of the United States government and from the State of Pennsylvania and that I merely drew the obvious inference that if the proper cost of living is \$780 yearly and the annual wages of the heads of families average but \$503, or even \$600, there must be a good many heads of families who do not have enough to live properly.

I also stated in this letter: "It is my earnest desire to give a truthful account of the opinions on both sides of this disputed question and I am quite willing to include in my paper any further remarks that the Anthracite Section of the A. I. M. E. may wish to make with regard to wages and living conditions, and I am willing to accept any reasonable modifications of my own remarks. My own opinion is that in denying me the privilege of quoting official reports you lay yourself open to the reproach of taking a partisan view of a disputed question and of violating the ancient legal maxim: *Audiat ut altera pars*. (Let the other side be heard.) And it does not seem to me that it is the proper function of a technical society to suppress evidence, as, according to my view, you will suppress it, if you deny me the right to quote these governmental statistics."

After fully considering all the issues involved and after consultation with a number of engineers and economists, I am still of the opinion that there was no valid reason for the action of the Institute in requesting the International Engineering Congress to modify my paper to suit the dictum of the Anthracite Section. I still feel that I was justified in publishing these statistics and remarks, and this opinion was supported in a meeting held at the International Engineering Congress headquarters in San Francisco on June 12, 1916, at which were present R. E. Cranston, William S. Noyes, T. A. Rickard, and Frank H. Probert, members of the Institute, and J. S. Hess, E. J. Dupuy, and W. A. Cattell, officials of the Congress. This meeting was called to consider the following telegram:

"Wilkesbarre, Pa., June 11, 1916. W. F. Durand, Chairman International Congress, San Francisco, Calif. Your letters and Mr. Shockey's revision have been considered by the Board of the Anthracite Section of the Institute. The Board insists that Mr. Shockey's rights do not include the right to misrepresent conditions in the anthracite region of which he knows nothing. They unanimously resent his statements. Are prepared to refute them and still insist that all reference to the anthracite region be expunged from the paper by order of the board of directors of the anthracite section of the American Institute of Mining Engineers. Signed, Paul Sterling, Secretary."

After the meeting a telegram was sent by the Secretary of the Congress to the chairman, W. F. Durand, then at Brooklyn, as follows:

"After careful consideration all present fully agreed

Congress Committee justified in publishing Shockey's paper as amended."

However, Mr. Durand, on his return from New York, did not consider it advisable to oppose the resolution of the directors of the Institute as quoted above, and after discussion I consented to omit the remarks and statistics in question and to replace them by the note appearing at the beginning of this communication. I distinctly reserved the right to deal with the controversy elsewhere as I saw fit.

On thinking the matter over, the action of the Institute in seeking to suppress these well-known statistics seems to me not only futile but stupid, and this for the reason that when the Institute passed the resolution on June 23 similar statistics had been published and read by all of those interested in the question. Such statistics were scattered broadcast in the book 'Anthracite,' written by Scott Nearing, which book was circulated as a brief by the anthracite miners before their conference with the anthracite operators and the matter was well summarized by J. P. White, president of the United Mine Workers, in his statement to the press, issued on February 21, 1916, wherein he stated:

"The annual earnings of miners, laborers, other inside men and outside workmen average not more than \$600 a year. The United States Bureau of Labor and Statistics estimates that a man cannot support his family in decency for less than \$750."

As is well known, the conference between the miners and the anthracite operators was held in New York from February 21 to April 30, 1916, resulting in increased wages and lessened hours of work; this agreement is to last for four years. Anything published now will have no influence on any contract that may be made at the expiration of the present agreement. Hence, there can be no possible harm in my publishing the statistics here. And it seems to me that I owe it to my fellow-members of the Institute and to the general public to give the details of this controversy in order to find out whether this censorship of the Institute is for the best interests of all concerned, that is, the anthracite operators, miners, the engineers, and last, but most important, the general public. In other words, is it best that the directors of a technical society shall act as censors as regards statements relating to labor questions, or should the various technical societies, in this case the Institute, stand for free speech and open discussion? I hold that the action of the Institute in censoring Government statistics is contrary to public policy and, in this particular case, most ill judged. It also seems to me that the publication in my article of these Government statistics offered the Anthracite Section a very favorable opportunity to correct any false statements and that they should have welcomed the publication instead of attempting to suppress it.

Prominent in wolframite, the tungstate of manganese and iron, in Argentina is of growing importance. The mineral is found almost exclusively in veins of quartz with mica.

The Wilmington Decision on Flotation—II

Text of Opinion by Judge Bradford in the U. S. District Court

The weight of the evidence is that the quantity of oil to ore necessary for the conduct of the process specified in the Froment patent would be from 12% to 15% of the weight of the ore, and this seems to accord with the statements in the patent that a "kind of metallic magma" is formed and that "the metallic spherules pressed one against the other, will become grouped in a magma clearly separated from the remainder of the liquid." These statements, I think, are inconsistent with any idea that under the Froment process the metallic particles were coated with oil of the extreme thinness characterizing the process of the first patent in suit; the thickness of the film in that process, according to scientific evidence, being only one one hundred thousandths part of an inch and imperceptible to the senses, as compared with a thickness of from sixteen to thirty-two one hundred thousandths of an inch in the Cattermole process and from eighty-five to two hundred and forty one hundred thousandths of an inch in the Froment process. The British Froment patent is in substance the same as the Italian patent and in neither of them does it appear that there was present in the Froment process the very minute quantity of oil of the first patent in suit. The Froment British patent was assigned to Ballot, one of the patentees in the first patent in suit, November 17, 1903, for the benefit of the plaintiff when organized, and in the assignment Froment covenanted that he would forthwith forward or hand to the purchaser the "plans and diagrams of the plant relating to the said invention with a full description of the working of the process." Pursuant to this covenant there were transmitted to Ballot plans and diagrams and a paper, in evidence, containing a "description and instructions for the concentration of ores" under the Froment process. It is dated December 29, 1903. The instructions recommend the use of oil in proportions varying from 1% to 3½%, according to the different percentages of metal in the ore. Notwithstanding the low percentage of oil mentioned in the Froment description, I have reached the conclusion that it contained no disclosure of the process of the first patent in suit. The evidence on the subject of the Froment description is voluminous and conflicting, but there are facts and circumstances which have satisfied me that the process of the first patent in suit was not discoverable from that description by men skilled in the art of ore concentration. Dr. Liehmann states that the Froment process as disclosed in the patents as well as the Froment process as disclosed in the description are "incapable of being carried out successfully." There is uncontradicted evidence that Sulman, Picard and Ballot, after the assignment of the Froment British patent and the receipt of the Froment description and instructions,

made persistent efforts to operate the Froment process successfully, but only met with failure, and that the model apparatus sent by Froment to Ballot was treated as worthless and discarded or "scrapped." Sulman, Picard and Ballot were scientific men of large experience in the art of ore concentration, and had the Froment patents or description disclosed or suggested the process of the first patent in suit, it is to be assumed that they would have utilized it instead of prolonging their attempt until March, 1905, to perfect granulation under the Cattermole process. The fact that they did not utilize it affords the strongest evidence that the Froment description did not suggest a process in which the minute quantity of oil required by the first patent in suit could be successfully used in ore concentration.

The defendant relies on patent No. 793,808, of July 4, 1905, to Sulman and Picard, for 'Improvements in or relating to ore concentration.' The patent states:

"The present invention relates to the concentration of ores by separation of the metalliferous constituents and graphite, carbon, sulfur, and the like from the gangue by means of oils, grease, tar, or any similar substance which has a preferential affinity for metalliferous matter over gangue. According to this invention we utilize the power which is possessed by films or bubbles of air or other gas of attaching themselves to solid particles moistened by oil or the like."

Two methods of carrying out the invention are stated. The first is as follows:

"According to one method of carrying out our invention suitably-crushed ore is suspended in water. To this suspension a proportion of oil, grease, or tar (hereinafter referred to as 'oil') is added and duly mixed with the mass by any suitable means in quantity insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone. A suitable gas is now generated in or introduced into the mixture, such as air, carbonic-acid gas, sulfuretted hydrogen, or the like. For example, bicarbonates or carbonates, either soluble or insoluble in water (preferably the latter) or easily-decomposable sulfids and the like may be used with acid solution. In such cases, if desired, the addition of acid may be made to the mixture after the addition of the gas-producing reagent. In the case of solutions containing free alkali the addition of acid sufficient to neutralize this must be made before the gas is produced. If desirable, gaseous bubbles may be produced by electrolytic methods or by means of various other known reactions."

The second method is stated as follows:

"According to another method of carrying out this invention the oil is not added alone; but the pulp is submitted to the action of a current of air or other gas bub-

bles, the air or other gas being first suitably charged either with the vapor of a volatile oil, such as petroleum of low boiling-point, or with the spray of any other suitable volatile or non-volatile or fixed oil or the like. The oil may be sprayed or reduced to a state of such fine division that minute globules of the same can remain temporarily suspended in an air or other gas current by the use of any suitable spraying or atomizing device and the air-current introduced into the ore-pulp, preferably at the bottom, by means of a pipe or pipes provided with suitable perforations or by other suitable contrivance. The minute oil globules or the condensed vapors or volatile oils attach themselves to the metalliferous particles in preference to the gangue."

The patent then states:

"The oiled metalliferous particles resulting from either of the processes above described have the power of attaching to themselves with a greater comparative strength than the gangue particles the films or bubbles of gas which exist in the mass and are thus raised to the surface of the liquor by gaseous flotation. They can then be removed by skimming or other suitable means. The gangue particles unwetted by oil or grease are not floated up with the oiled mineral particles, and thus in the main remain at the bottom of the vessel containing the mixture. The oil can then be removed from the oiled mineral by any suitable known means."

There are certain features in this process as described similar to features in the process of the first patent in suit. The amount of oil coating the metallic particles being insufficient to raise them through the flotation power of the oil alone, gaseous bubbles, whether generated in the mixture, or introduced into it through the perforated spiral coil, attaching themselves to the oiled metallic particles, rise to the surface with those particles, so as to be removed by skimming or other suitable means, the gangue particles remaining in the main at the bottom of the vessel containing the mixture. This process patent, issued to Sulman and Picard upon an application filed October 5, 1903, affords cogent circumstantial evidence of the patentability of the process of the first patent in suit. I have been unable to read the description of the patent immediately under consideration without reaching three conclusions: first, that Sulman and Picard had conceived an idea, though imperfect, of an air flotation of the metallic particles; secondly, that they had no conception whatever of the possibility of conducting such a process with the minute quantity of oil specified in the first patent in suit; and thirdly, that they contemplated the use of a very much larger proportion of oil. In view of the fact that both patentees in No. 793,808 were two of the three patentees of the process of the first patent in suit, it is so improbable as to amount to a moral impossibility that for nearly a year and a half after the filing of the application for patent No. 793,808 they should have devoted their attention and efforts to the solution of the problem of the proper quantity or proportion of oil to be used in securing improved granulation in the Cattermole process, and have been astonished

at the making of the discovery in March, 1905, if they had recognized or believed that an economical and efficient process of ore concentration could be carried on by the use of oil amounting to only a fraction of one per cent. Any further discussion of patent No. 793,808, I think, is unnecessary.

I have found nothing in the prior art to anticipate the process of the first patent in suit or to negative invention. Objection has been made that the disclosures of the patent are not sufficient, in that the application of the process to different ores necessitates some difference in treatment involving a variation in temperature, or in the amount of acid or of oil, and the patent omits to specify the degree or amount of such variation with respect to the treatment of the different ores. But to require of an inventor such a specification would be to demand an impossibility. The patent recognizes that different ores may require a different treatment. The description states:

"The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilizing the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine which oily substance yields the proportion of froth or scum desired. * * * The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent of the ore; but this proportion has been found suitable and economical."

And claims 1 and 12 mention oil amounting to "a fraction of one per cent." A close or exact adjustment of quantities and proportions of oil in the treatment of different ores within the limits prescribed in the patent is a matter calling, not for the exercise of inventive genius, but for the skill of the metallurgical engineer conducting or superintending the operation. In *Mowry v. Whitney*, 14 Wall. 620, the court said:

"The specification, then, is to be addressed to those skilled in the art, and is to be comprehensible by them. It may be sufficient, though the unskilled may not be able to gather from it how to use the invention. And it is evident that the definiteness of the specification must vary with the nature of its subject. Addressed as it is to those skilled in the art, it may leave something to their skill in applying the invention, but it should not mislead them."

Some embarrassment in the treatment of this case has been caused by the use of different adjectives and descriptive phraseology as applied to the same thing. If a patent for a process of ore concentration, or any other process, clearly sets forth the ingredients and the practical steps to be observed in conducting it the misuse of terms as applied to the operation of natural laws involved in the process is immaterial. In the administration of justice it is the aim of courts to deal with substance and not to be influenced by mere form not calculated to mislead as to substance; and where a material and substantial thing is plainly identified in the patent

claims and description a mistaken misnomer is harmless and negligible. Inventors are not required to understand the natural laws under which new and useful results are obtained from ingredients, elements, apparatus and manipulation requisite for the conduct of the process. There are occult laws, unknown and inexplicable, to which tangible results must be attributed. In the nature of things an inventor, so long as he clearly sets forth the practical means and steps for securing those results, does all that the law requires or can reasonably be expected of him. So, it is unimportant that to the same thing one name may be applied by one person and a different name by another, the identity clearly appearing. The truth of this statement has been strikingly exemplified in this case in the language of patents and other publications, judicial decisions, the oral testimony and the arguments of counsel.

During the trial a large number of experiments were made for the purpose of illustrating ore concentration processes described in patents and other printed publications of the prior art. Such experiments are illuminating and helpful, or deceptive and misleading, according to the conditions under which they are performed. As a general rule, in such experiments processes of the prior art should be illustrated by means of apparatus of the prior art in which such processes were conducted at or about the time of invention and under the conditions then understood and observed. To construct apparatus long after, and in view of subsequently acquired knowledge, in order to show a prior process tends to produce embarrassment and confusion touching the nature and operation of the process inquired into. In *Naylor v. Alsop Process Co.*, 168 Fed. 911, the circuit court of appeals for the eighth circuit said:

"An expert, however, cannot take a process patent which has never been applied industrially and work the process in his laboratory and discover therefrom something which is not disclosed on the face of the patent, and then transfer that experience back to the time of the patent, and make it a part of the prior art for the purpose of defeating a meritorious invention."

In *Schmertz Wire Glass Co. v. Western Glass Co.*, 178 Fed. 977, the court said:

"By using twentieth century magnifying glasses, a nineteenth century method has been found efficient, which never was so before, and the immensely important point of view of an advanced art is thus unfairly used to discover an original conception never acted on or made anything of, and which never had any practical or beneficial existence."

The material question for the court is not whether any given apparatus is capable, under manipulation employed in view of existing knowledge, of carrying on the prior process inquired into, but whether the process was carried on as a part of the prior art, and, in case of an ore concentration process, by way of illustration, under what conditions as to ingredients, strength and extent of agitation and other essential factors; and only so far as those conditions are reproduced and faithfully observed

in demonstrations in court, due allowance being made for the difference in the requirements of mill operations, is the experiment entitled to probative force. The difference between the conduct of the process in the mill and the necessarily interrupted or broken character of the process as disclosed in experiments in court and laboratory tests in subsequently constructed apparatus must be borne in mind in determining the weight to be given to such experiments or tests.

On the whole I am satisfied that the first patent in suit must be sustained as to claims 1 and 12, but not as to claim 9. The two former are definite, specifying and limiting the amount of oil to be used; claim 1 mentioning "a small proportion * * * amounting to a fraction of one per cent on the ore," and claim 12 "a fraction of one per cent of oil on the ore." Claim 9 mentions "a small quantity of oil." This is so indefinite as to render the claim void, unless on consideration of the patent as a whole the claim can by construction be limited to the use of oil amounting to only a fraction of one per cent. The patentability of the process of the first patent in suit resides in the use of oil in the extremely minute proportion disclosed in the descriptive portion of the patent to effect separation of froth with its metallic particles from the remainder of the mixture by flotation. The amount there disclosed is not in excess of "a fraction of one per cent on the ore" and may be only one-tenth of one per cent on the ore, or even less. If, then, by construction claim 9 should be so limited as to be restricted to the use of oil amounting to only a fraction of one per cent on the ore, that claim is in substance, though not in exact phraseology, the same as claim 1 for the reason that in any event from the nature of the invention it would be necessary to read "by flotation" into claim 9, if in other respects valid. But a limitation by construction producing such a result is inadmissible. It is suggested by one of the plaintiff's counsel in his consideration of claim 9, that one for the purpose of securing immunity from the consequences of infringement might use an oil useful in the process, and add to it an oil not useful as applied to his particular ore, and, on being sued for infringement contend, "I am using 1.1% of oil. I do not infringe. I am using more than a fraction of 1% of oil." But the existence of this possibility does not, I think, warrant such a construction of claim 9 as is urged; for the disclosure of the patent does not extend to the use of 1.1% of oil, but is limited to a fraction of 1%. If it be assumed, however, that the claims in suit contemplate and require the use of efficient, as distinguished from inefficient, oil, and if in the case suggested an inoperative oil should be used by way of addition to the efficient oil so contemplated and required it might be a question, upon which, however, no opinion is here expressed, whether the addition of the inoperative oil to the efficient oil could be treated as an increment to the amount of oil so contemplated and required, operating as a shield to protect the wrongdoer. But this question would arise in a suit based upon claim 1 or 12, as well as in a suit based upon claim 9, were it proper by construe-

tion, in order to save it, to limit "a small quantity of oil" to a quantity of oil amounting only to a fraction of one per cent on the ore, and therefore fails to require or justify the suggested limitation of claim 9, without which it must fall.

On the question of infringement of the first patent in suit I have no doubt. It was practically admitted by counsel for the defendant in opening the defense that it had infringed the three patents in suit by its operations at Miami within four months next before the filing of the bill; he stating "in the first installation which was made at Miami, we make no serious contention that it did not represent the operations set forth in the three patents in suit." It appears that the infringing operations were carried on in apparatus built in imitation of the plaintiff's standard machine. But the defendant denies that it infringed by its concentration of ore in its pneumatic flotation plant through its practice of the process of patent No. 733,808 of July 4, 1905, to Sulman and Picard, hereinbefore discussed, as modified by the use of what is known as the Callow cell. Counsel for the defendant, however, stated with respect to the process of the patents in suit and the process as carried on by the defendant under the Sulman and Picard patent, with the apparatus of the Callow cell:

"The broad principles are the same in both. In both we have the pulp, consisting of ore held in suspension in water. In both the water is modified to lower its surface tension. In both the buoyancy comes from air-bubbles."

The defendant in its operations also used the minute proportion of oil mentioned in the first patent in suit. It does not use acid in its process; but this fact is immaterial so far as the question of infringement is concerned for the reason that it appears both from the claims and the description of that patent that the use of acid is optional, the description stating that "the water in which the oiling is effected is preferably slightly acidified," and claims 1 and 12, as well as claim 9, unlike a majority of them, not requiring acid. The defendant's counsel also stated that the difference between its process and that of the complainant "comes after the air bubbles have attached themselves to the mineral particles." I do not think there is any such difference between the processes as to negative infringement. It was in substance admitted on the part of the defendant that if the first patent in suit is a pioneer patent and properly drawn the operations carried on at Miami were an infringement. Whether that patent is technically a pioneer patent or not, it certainly was highly meritorious and, I think, partook of the nature of a pioneer patent so far as the very successful use of oil amounting to only a fraction of one per cent is concerned. Its claims merit much liberality of construction and when so construed embrace the operations of the defendant at Miami. The purpose of each process is the concentration of the ore through the separation of the metallic particles from the gangue. In the plaintiff's process the separation is effected through the rising of air-bubbles to which are attached

the metallic particles, through the mixture to the top, and the formation of a froth or scum on the surface, which can by simple means be removed with the contained metallic particles. In the defendant's process the separation is effected through the rising of air-bubbles to which are attached the metallic particles through the mixture of the top and the floating away into a launder of either the original bubbles to which the metallic particles were first attached or succeeding and on-coming bubbles which have caught and buoyed up to the surface the metallic particles escaping from bursting bubbles. By the use of a launder a recovery of the metallic particles is readily effected. The defendant contends that since its abandonment of its original infringing process at Miami above referred to, it has not and does not infringe the first patent in suit, for the reason that it does not in its process produce the coherent and permanent froth of the process of that patent. It appears from the evidence, it is true, that the bubble froth in the defendant's process is not as coherent and permanent as the froth of the process of the first patent in suit; but both are mineral froths, and that of the defendant is sufficiently permanent to effect through air flotation an efficient separation of the metallic particles from the rest of the mixture. Air-bubbles, however produced, in water not modified or contaminated—pure water—on reaching the surface will immediately collapse, and the formation of bubble or air froth is impossible; but air-bubbles in modified water will not instantly disappear on gaining the surface. The degree of their permanency after reaching the top largely depends on the degree of modification of the water.

There has been much expert evidence relating to the subject of surface tension to the effect that in the case of pure water it is so great as to cause the instant collapse of bubbles of air rising to the surface; but that through modification of the water, the tension is so reduced in force as to permit the continued existence for a greater or less period of bubbles of air reaching the surface. The water in the ore pulp of the defendant's process is strongly modified and of necessity the bubbles on reaching the surface do not and cannot instantly disappear; but, on the contrary, in accordance with the operation of natural laws about which there is no conflict, persist and continue on the surface as a bubble or air froth. But whatever may be the true explanation of the phenomenon of the continuance and disappearance of escaping bubbles, the fact remains that the defendant's process discloses a froth consisting of bubbles which have passed through modified water to the surface of the mixture, and float thereon, and with their freight of metallic particles flow over the edge of the containing vessel into a launder, thus effectively separating the valuable mineral from the gangue particles. Coherency and permanency in a froth admit of degrees, and such a degree as insures by air flotation an efficient and final separation between the metal and the gangue, whatever may be the duration of the froth, comes within the process of the first patent in suit.

The defendant further insists that its process lacks

violent agitation which it claims is an essential of the process of the first patent in suit. Each of the twelve claims of the patent mentions as an element of the process "agitating the mixture," but not one of them mentions violent agitation. It is, however, urged that the descriptive portion of a patent for a process must contain a full and fair disclosure of the patented invention the claims must be read in the light of the description, and as violent agitation is included in the description the claims with respect to agitation must be limited to violent agitation. But the description nowhere mentions "violent agitation" or uses any equivalent expression. It mentions "vigorous agitation," and states that in the case of the application of the patented process to an ore containing "ferruginous blende, galena, and gangue consisting of quartz, rhodonite, and garnet," the mixture is "briskly agitated." It also describes as a part of the apparatus for carrying on the process a "rotatable stirrer." But I do not find in the description any specification of any rate of speed for the rotatable stirrer, or of any standard for the determination of what constitutes a "vigorous agitation" of the mixture, or a specification of any test for ascertaining whether the mixture is "briskly agitated." All these matters were left to the judgment and skill of the metallurgical engineer conducting or superintending the operation of the process, involving empirical investigation to reach the best results. The strength of agitation referred to in the description clearly admits of different degrees, varying from one another in the application of the process to different ores and under changing conditions. There is no room for doubt that agitation of the mixture in the process of the defendant is sufficiently vigorous or brisk to insure efficient ore concentration by an air flotation process such as is accomplished by the complainant by agitation under the process of the first patent in suit. This being true the use of mere adjectives in the descriptive portion of the patent with respect to agitation is unimportant. In order that the bubbles in the pulp mixture may come in contact with the metallic particles there must be such movement between them as cannot be wholly accounted for by selectivity as between them, and their movement so far as not accounted for by selectivity is the result of agitation; and whether such agitation results from the stirring or beating of the mixture or the forcing or admission of air into it is immaterial; for what this court is dealing with is not an apparatus patent but a process patent.

Patent No. 1,104,755, of July 21, 1914, to John M. Callow, covers apparatus relating to ore concentration. The evidence shows that the defendant in its concentration of ore in its pneumatic flotation plant employs the process of patent No. 793,808, of July 4, 1905, to Sulman and Picard, hereinbefore discussed, as modified by the use of certain apparatus substantially the same as a portion of the apparatus, the operation of which is described in the above-mentioned Callow patent, as follows:

"From the foregoing, it will be understood that I employ no mechanical propellers for producing the neces-

sary agitation and beating into the froth of large volumes of air, but that I depend upon the compressed air admitted through a porous body which has the function of splitting up the air into innumerable fine streams and distributing these fine streams over and into substantially the entire surface of the pulp, whereby immediately upon the introduction of the air, a more or less violent agitation or ebullition takes place and a froth begins to generate and to finally rise and form on the surface of the pulp."

The character of the agitation above described is also clearly recognized in the claims of the Callow patent.

The combination of claim 1 of the first patent in suit contains the following elements: (1) Mixing powdered ore with water; (2) adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent on the ore); (3) agitating the mixture until the oil-coated mineral matter forms into a froth; and (4) separating the froth from the remainder by flotation. The elements in the combination of claim 12 are (1) separating the mineral from gangue by coating the mineral with oil in water containing a fraction of one per cent of oil on the ore; (2) agitating the mixture to cause the oil-coated mineral to form a froth; and (3) separating the froth from the remainder of the mixture. The elements entering into the defendant's infringing process are the same as those of claims 1 and 12 of the first patent in suit. There is no escape, I think, from the conclusion, not only that the defendant infringed the first patent in suit by carrying on the process of ore concentration in its first installation at Miami in apparatus in imitation of the plaintiff's standard machine, but also has infringed and is infringing the same patent by carrying on the process of ore concentration in its pneumatic flotation plant at the same place.

The second patent in suit, No. 962,678, of June 28, 1910, to Sulman, Greenway and Higgins, is for "Improvements in ore concentration." The patentees state that the object of the invention is "to separate certain constituents of an ore such as metallic sulfides from other constituents such as gangue when the ore is suspended in a liquid such as water." This patent is distinguishable from the first patent in suit; the object of the invention of that patent being, as stated, "to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue." It appears from the patent as a whole that "other substances which have a preferential affinity for metalliferous matter over gangue" are restricted to those of an oily nature. Such substances as mentioned in the various claims of the patent are "an oily liquid," "an oily substance," "oleic acid," "oleic soap solution" and "oil." No other frothing agent than the above substances enters into the process of the patent. The essence of the invention of the first patent in suit was the restriction of the "oily substance" to "a fraction of one per cent on the ore." In the process of the second pat-

ent in suit no oil, fatty acid, or oily substance is introduced into the mixture. The description contains the following statement:

"According to this invention the crushed ore is mixed with water containing in solution a small percentage of a mineral-frothing agent, (that is of one or more organic substances which enable metallic sulfids to float under conditions hereinafter specified) and containing also a small percentage of a suitable acid such as sulfuric acid, and the mixture is thoroughly agitated; a gas is liberated in, generated in, or effectively introduced into the mixture and the ore particles come in contact with the gas and the result is that metallic sulfid particles float to the surface in the form of a froth or scum, and can thereafter be separated by any well-known means. Among the organic substances which in solution we have found suitable for use as mineral-frothing agents with certain ores are amyl acetate and other esters; phenol and its homologues; benzoic, valeric and lactic acids; acetones and other ketones such as camphor. In some cases a mixture of two such mineral-frothing agents gives a better result than a single agent. * * * The present process differs from the two before mentioned types and from other known concentration processes by the introduction into the acidified ore pulp of a small quantity of a mineral-frothing agent, that is, an organic compound in solution of the kind above referred to and by the fact that the metalliferous particles are brought to the surface in the form of a froth or scum not by mechanical means but by the attachment of air or other gas bubbles thereto. In the frothing process hitherto known the substances used to secure the formation of a mineral-bearing froth has been oil or an oily liquid immiscible with water. According to this invention the mineral-frothing agent consists of an organic compound contained in solution in the acidified water."

* * * * *

It will be observed that no one of the claims of the second patent in suit requires as an element an oily substance or liquid, as is essential in the process of the first patent in suit, and all of the claims relied on require the introduction into the mixture of "a small quantity" of a "mineral frothing agent" or an "organic mineral frothing agent." The amount of the mineral frothing agent employed in the process is not confined to a fraction of one per cent on the ore, but must be a small quantity, evidently to be determined by the metallurgical engineer conducting or superintending the operation according to the requirements of the different ores. The novelty of this invention is to be found, not in any restriction of the amount of the mineral frothing agent to any stated proportion, for there is none, but in the fact that a mineral frothing agent as the means of separating the metallic particles from the gangue is substituted for the oil, fatty acid or other oily substance essential to the process of the first patent in suit. Such substitution has produced successful results, and, I think, involved invention. Frothing agents had theretofore been used in ore concentration, but not in the absence of an oily

ingredient. Even were the grounds on which the validity of the patent can be sustained less clear, it should have the benefit of the presumption of validity arising from the grant of letters. That the defendant has infringed the claims in suit of the second patent is established by the evidence.

The third patent in suit, No. 1,099,699, of June 9, 1914, to H. H. Greenway, assignor to plaintiff, is for 'Improvements in the concentration of ores.' It states:

"This invention relates to the concentration of ores and has been applied in practice to the concentration of copper ores the object being to separate certain constituents of the ore such as copper sulfids (for example in the form of copper pyrites) or metallic copper (natural or reduced) from other constituents such as gangue when the ore is suspended in a liquid such as water. The present process is a modification of the invention described in U. S. patent to H. L. Sulman, A. H. Higgins and myself, No. 962,678, granted June 28, 1910. The process therein described is applicable generally to the recovery of metallic sulfids and like floatable metalliferous matter and in the case of lead and zinc sulfids to which the process has been largely applied it is necessary for efficient working that the pulp should be slightly acidified, and in most cases in practice the pulp is heated. It is now found that with copper ore such as an ore containing copper pyrites effective separation is obtained in the cold without the use of acid by employing as mineral frothing agents, aromatic hydroxy compounds such as phenol, cresol, or mixtures containing the same. The process of concentrating ores containing copper sulfid or metallic copper according to this invention consists in mixing the powdered ore with water containing in solution a minute quantity of aromatic hydroxy compound such as phenol or cresol but without mineral acid and in the cold, agitating the mixture to form a froth and separating the froth."

The first twelve claims of the patent are in suit, but it is unnecessary to set them forth in full. I do not find any element of patentability in the process of this patent. It is stated in the description that the process can be carried on "without mineral acid and in the cold," and "is carried out in the cold and no acid is added to the pulp." Under the second patent in suit the use of heat is optional, and no patentability can be attributed to the process of the third patent in suit on the ground that the process is carried on in the cold or without heat; for patentability can never result from the mere omission to do something, the doing or not doing of which is optional. There is a question on which a difference of opinion has been expressed, whether in the process of the second patent in suit the use of acid is also optional. The description in the patent considered alone requires the use of acid; but while five of the nine claims mention "acidified water," the remaining four do not refer to acid. It is not altogether clear to me under these circumstances whether the use of acid is not optional. But however that may be, I think that, in view of the process of the prior art an omission to use acid in the process of the third patent in suit cannot confer patentability upon it.

Necessities of the Chilean Mining Industry

*The practical results of the Chilean Congress of Mining and Metallurgy, held at Santiago on April 25, 1916, have been shown in the list of conclusions and recommendations presented to the Ministry of Industry and Public Works. Briefly these are as follows:

1. The establishment of a Federal department or bureau of mines with a self-contained organization, responsible only to the Ministry of Industry.

2. The prompt solution of problems connected with the proposed national mercantile marine laws.

3. The systematic survey of the coal and petroleum deposits of the Republic.

4. The institution of a permanent geological survey.

5. The making of a topographical map of the country and securing of data on meteorological conditions.

6. Reform of the mining code in accordance with ideas expressed by the National Mining Society.

7. The making of laws with respect to deposits of petroleum and the appropriation by the government of sufficient funds for a complete survey of petroleum lands.

8. A continuation of the survey of available water-powers.

9. A standardization of the railroad gauges for all future private or branch railways.

10. The construction of the branch railways most needed for taking out ore and the removal of the difficulties for such work in certain zones.

11. A re-organization of the Longitudinal railroad in the interests of more economical operation.

12. The making of railway tariffs that will be in proportion or relation to the mineral contents of the ore carried; the acquiring of facilities for the better and quicker loading of cars at the various stations.

13. The obligation on the part of the various districts to spend the money received in mining taxes upon roads in the mining regions.

14. The construction of first-class roads from the railroad to those mining centres that are of sufficient importance.

15. The execution of needed port works, particularly at Antofagasta and Lebu.

16. The repairing or re-construction of wharves and docks that are in bad condition.

17. The organization of a nitrate association under Federal control for the promulgation of laws for the common good.

18. The study of the supply of water in the nitrate fields, and the application of methods of irrigation.

19. The permanent organization of nitrate credits on a plan similar to that formulated in August 1914, with such modifications as experience has required.

20. The dictation of Governmental measures for the sale of nitrate in foreign countries, so that the interests

of the producers shall agree with those of the Government.

21. The securing of means whereby the large consumers of coal may take part in the exploitation of coal deposits.

22. The re-organization of mining schools, and separation of the various schools into proper classes.

23. The reform of the patent laws, whereby inventors are better protected as to title and against infringement; the division of the terms of patents; the provision for the appropriation of patents for the common good.

24. The reduction, or doing away with entirely, of customs on all imported mining necessities, particularly coal and oil, as long as they are not produced in sufficient quantities in the country.

25. The prompt approval of workmen's compensation laws.

In addition to the general recommendations, a number of special ones were made. They are:

1. The creation of an industrial laboratory for the analyses of and chemical experimentation on a small working scale with the various products of the nitrate fields, particularly with *caliche*.

2. The institution of courses applying to the nitrate industry in the higher schools of the Republic.

3. The fixing of an annual subsidy for propaganda on the use of nitrate.

4. The giving of premiums to associations of nitrate producers which develop new markets or increase the consumption in the present ones.

5. The giving of premiums to inventors who find new uses for nitrate and its by-products, especially iodine.

6. The offering of guarantees to those plants which install new and more economical systems of extraction.

7. The giving of premiums to inventors who devise more economical methods of producing nitrate.

8. The giving of a prize of \$10,000 to the author of the best work (book) on the technique and practice of nitrate production; this work to be used as a text in industrial schools of the Republic.

9. The giving of a subsidy for each ton of iron produced in the country from its ores.

10. The offering of guarantees to metallurgical plants, producing copper ingots.

11. The offering of subsidies for the construction of necessary private railroads.

12. The offering of subsidies to plants making metallurgical coke from Chilean coals.

13. The re-establishment of a subsidy to plants making sulphuric acid for commercial use.

14. The study and construction of hydro-electric plants in the nitrate fields.

15. The publication of data explaining mining and nitrate privileges.

16. The absolute prohibition of the use of alcoholic beverages and of gambling in the mining and nitrate regions.

17. The general knowledge on mining and nitrate production should be increased.

*Abstract from *Teniente Topics*, published by Braden Copper Co., Chile.

The Stoddard Mill—A Copper Concentrator

By C. B. Clyde

A 100-ton copper concentrator sounds small these days, but there is no more significant bit of evidence of the advance in the metallurgy of copper than the fact that such a plant is an economic possibility. The large increase in extraction by the new methods, the greatly decreased cost of the milling-plant, and the lower operating cost are facts hardly appreciated as yet by the smaller mine-owners.

One of the first of these companies to take advantage of the recent developments is the Stoddard Milling Company, of Stoddard, Arizona, a company formed by the Stoddard Mines Company and its neighbor, the Copper Queen Gold Mining Company, to provide reduction works for a quantity of low-grade ore that had been opened up in both mines. These properties are situated in Yavapai county, Arizona, six miles from the railroad at Mayer. The ore is chalcopyrite of medium hardness occurring as stringers and enriched masses in the Yavapai schist.

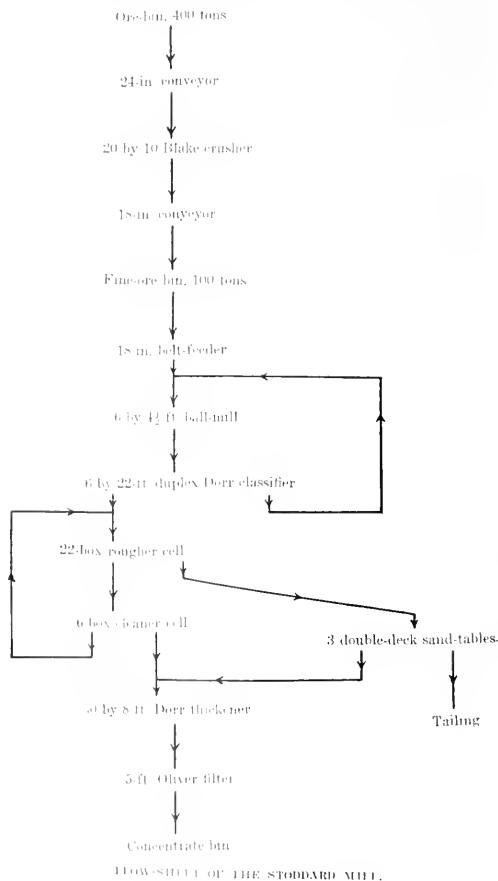
Tests on samples of the ores indicated a ready recovery of the sulphides by flotation, and on the recommendation of H. Kenyon Burch a flow-sheet similar to the Inspiration treatment was adopted. The simplicity of this flow-sheet is apparent, the only complication being introduced by the need of handling the ore from the two properties in alternate periods of several days each, and keeping the concentrates separate. This made it necessary that the concentrate thickening and dewatering division be in duplicate to allow the clean-up of a run on ore to continue for some hours after the other ore had started through the upper part of the mill.

The site selected was on a ridge midway between the two mines and about 1100 ft. from each. Flat-bottom crude-ore bins of 400-ton capacity were erected at a point convenient to both tramways, a partition separating the two ore-supplies. On top a grizzly made of rails, spaced 10 inches apart, places a limit on the size of ore dumped into the bin. The two tramways are at elevations differing by 12 ft. and are carried out over the centre of the bin on a wooden trestle.

Ore is drawn from the bin through rack and pinion gates into chutes that load a belt conveyor. Arc gates in the chutes are operated intermittently by the attendant. The belt is 24 in. wide and travels 50 ft. per minute. This slow speed is desirable on account of the large chunks of ore to be carried, and it also makes it possible to remove pieces of wood, or to sort high-grade and waste.

The conveyor discharges into a 20 by 10 m. Colorado Iron Works Blake crusher set 14 in., which in turn discharges on an 18 in. belt conveyor delivering the crushed ore to the fine-ore bin. This arrangement was chosen, instead of the simpler one of using but one conveyor and

placing the crusher on the bin, to secure a solid foundation for the crusher. It necessitated the digging of a deep pit for the tail-end of conveyor No. 2, but was well justified by the smooth running of the crusher. Another advantage, of no small importance, is that the drip of lubricating oil and grease from the crusher could not



get into the bin and mix with the ore to cause trouble later in the flotation department.

Power for the crusher-plant is furnished by a 25-hp. motor driving a counter-shaft from which the crusher and conveyor No. 2 are driven. Conveyor No. 1 is driven by a chain drive from the tail-shaft of conveyor No. 2. The fine-ore bin has a sloping bottom and holds 100 tons. A belt feeder is used to draw the ore from the bin and the rate of speed is controlled by the spacing of the

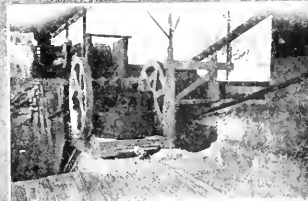
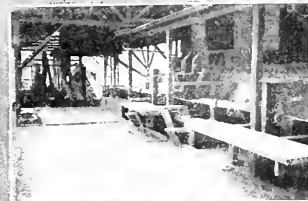
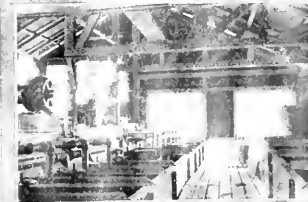
**TANK GRADE****MILL BIN****TRAMWAY TRESTLE****THICKENER FLOAT****LOWER END OF MILL****STODDARD MILL**

adjustable skirt-boards. This discharges into the feeder of a No. 64½ Marcy ball-mill. A 6 by 22-ft. Dorr duplex classifier is arranged in closed circuit with the mill, the slime-overflow going direct to the flotation department. The flotation oils are added to the oversize from the classifier, a feeder consisting of several flat-faced pulleys with adjustable scrapers being used for this purpose.

A 100-hp. motor is belted direct to the pinion-shaft of the ball-mill. A counter-shaft driven by a pulley on the extended pinion-shaft provides power for the classifier, belt-feeder, and also drives the 'table' counter-shaft on a lower floor.

The flotation equipment consists of a 16-box rougher-cell and a 6-box cleaner-cell of the Inspiration type. Briefly, these cells consist of a long steel tank having transverse partitions that divide them into the required number of boxes. Each partition has an adjustable gate at the bottom to permit and control the continuous flow of pulp through the cell. On one side adjustable overflow-lips regulate the height of discharge into the concentrate-launder. A removable air-distributor consisting of a cast-iron frame and grid holding a filter fabric is placed in the bottom of each box and connected to the air-header by a pipe running up through the centre of the box.

The rougher-concentrate is elevated by a diaphragm-pump to the feed-box of the cleaner-cell and a second diaphragm-pump returns the tailing from the cleaner to the rougher. These simple little pumps were installed as an experiment, but they performed in such a satisfactory manner that they were retained. The tailing from the

**OLIVER FILTER****JAW CRUSHER****CRUSHING PLANT****DORR THICKENER****MARCY MILL****FLOTATION CELLS**

rougher is sent to three Deister Machine Co.'s double-deck sand-tables, without any attempt to classify, the fineness of the pulp making it unnecessary and impracticable.

Two Dorr thickeners in 8 by 30-ft. redwood tanks are used to thicken the concentrate, one being reserved for each of the two mines. The tanks were spread apart to permit a blower and pump-room being placed between them. A No. 2 Root blower, furnishing air for the flotation cells and the filters, is placed here, also the vacuum-pump for the filters.

A 25-hp. motor drives a counter-shaft carried on concrete piers, from which power is taken for the blower, vacuum-pump, filter counter-shaft, thickener counter-shaft, and the centrifugal pump used in connection with the dry-vacuum system.

Two Oliver 5-ft. filters are placed in a room below this level. Each of these discharges its cake into a deep wide chute having two rack-and-pinion gates at the end. These chutes will hold about 17 tons each, and are in effect storage-bins. The lower end is high enough above the roadway to load directly into motor-trucks, which are used to haul concentrate to the railroad.

Sand and gravel for concrete was hauled in wagons from the river three-quarters of a mile distant, and stored in piles at the foot of the grade. From here it was later distributed by burros as required. All other building material and equipment was brought from Mayer over an old wagon road.

Timber was used entirely in the construction of the bins, tramway-trestle, and building, most of it being second-hand lumber from the San Francisco exposition. In order to minimize the fire-risk a number of plugs, each with its hose and reel, were placed at suitable points outside the mill.

All machinery is set on concrete foundations and provided with ample runways and operating platforms. In all cases the convenience and safety of the operators were regarded as being of the greatest importance.

Water for the mill is obtained from a well in the bed of the Agua Fria river, 3000 ft. distant, and is pumped by an Aldrich triplex pump to a 50,000 gal. mill-supply tank.

Electric power is obtained from the Arizona Power Co., a transformer station near the mill reducing the voltage to 110. With the incentive of a high price for copper, the construction work was rushed at top speed, and the mill was built in three months, being put in operation on August 15, 1916.

ARRANGEMENTS have just been completed at New York whereby the resources of the Engineering Foundation, under the auspices of the four principal national engineering societies, are placed at the disposal of the National Research Council, which was appointed by the National Academy of Science at the request of President Wilson. The object of the council is to coordinate the scientific research work of the country in order to secure efficiency in the solution of the problems of war and peace. The council was without funds until the Engi-

neering Foundation, established to further scientific and engineering research, offered to place its resources at the council's disposal, including the services of its secretary, Dr. Cary T. Hutchinson, to act as secretary of the council. The offer was accepted and plans for immediate activities have been placed in the hands of an executive committee.

Mine-Pumping

Mine-pumping is divided into two general classes, sinking and station-pumping. Station-pumping offers about the same problems as any pressure-pumping for efficient operation, having practically clear water. Occasionally there is the added difficulty of bad water, particularly in mines containing acidic water, where special equipment, brass-lined, must be provided for durability. The same is true of sulphurous waters in the oilfields, which will corrode and pit iron parts much like salt water, in a short time.

In mine-sinking, however, the greatest difficulties arise and each shaft is an individual problem. There must be taken into account the angle of incline, if any; the amount of the in-flow of water; the sharpness of the grit due to blasting; the kind of power available; the desirability of a pump that will "hold suction" well, for keeping the water completely down, and finally, the ultimate reliability of the plant to keep the shaft from being flooded. Then if more economical operation can be secured, a double advantage has been gained.

The steam-pump has been the sinking-pump most commonly used, so that its operation and construction are well understood by mine-mechanics. It can be used under most favorable circumstances, and is reliable. On the other hand, it has many limitations and disadvantages. It must be operated by either steam or compressed air; it has to start the column of water in the discharge at each pump-stroke, involving a heavy loss of power; and it exhausts the steam at full boiler-pressure, another loss.

Pumps of the centrifugal and rotary types are sometimes used, but their limitations are so great as to offset their advantages and render them less efficient and less dependable for practical sinking purposes. They hold suction poorly and are not flexible, requiring practically a fixed speed at all times and different speeds at different pressures, also increased speed to offset wear.

The continuous-acting plunger-pump is flexible, and can be run economically at any speed between say 25 to 100 ft. of piston-speed per minute, and changed as the shaft is deepened, as required. It can be started from the top of the ground without descending into the shaft, and will work equally well when submerged and can be re-packed in about five minutes, making such a type of sinker a most desirable one for mine-managers.—*Mining and Oil Bulletin.*

MANGANESE imports from India during the second quarter of 1916 amounted to 12,326 tons.

Block Method of Top-Slicing at Miami

By E. G. Deane

*A method of top-slicing has been devised at the Miami Copper Co.'s mine at Miami, Arizona, that differs radically in some ways from the customary methods.

The area of the orebody in which top-slicing is used is about 800 ft. square. The ore, while for the most part soft, is, nevertheless, considerably harder than the capping. The latter is silicious, seldom containing any clay or other binding material, and breaks into fine particles so it runs like sand if given the opportunity. Because of these facts, and because the ore is above the average grade of the mine, it has been mined by top-slicing.

Haulage-levels are opened 150 ft. apart, vertically, with two sub-levels between at 50-ft. intervals, to facilitate the building of chutes. These sub-levels are used during slicing for distributing air in the ventilation system. On the haulage-level the drifts are spaced on 50-ft. centres, and raises along these drifts are also spaced on 50-ft. centres, except the incline raises as hereafter noted. The raises are cribbed where necessary. Where the wear will be excessive, $\frac{1}{4}$ -in. iron plates are spiked to the top of every third set of cribbing.

When top-slicing was first used, an attempt was made to carry a slicing-face from fifty to several hundred feet long. Timber and other supplies were brought in through long drifts from an auxiliary shaft. Great difficulty was experienced in keeping these drifts open, the side pressure breaking the posts and the top weight breaking both caps and posts. Furthermore, the men could not work efficiently while these drifts were being repaired. The slicing-faces advanced irregularly, and in many ways the results were not all that could be desired. It was then decided to divide the slicing-area into blocks 200 ft. square and this was later changed to 250 ft. square.

At the centre of each block a two-compartment raise is put up as a supply-raise, the compartment being 2 ft. 6 in. and 4 ft. by 4 ft. 4 in., the smaller used as a man-way. Station sets of 12 by 12 timber with 9 or 10-ft. posts are put in and an ingersoll stretcher-bar air-hoist is mounted above the larger raise-compartment to use in

hoisting the timber and steel. Four bulkheads, built solidly of blocks of square timber, are inserted as shown in Fig. 1. Two of these are 7 by 11 ft. in size, and the other two 7 by 7 ft.

Two drifts, usually untimbered at first, are run out 100 ft. on the long axis of the supply-raise. At the end of each of these and at right angles to them, two drifts are driven 125 ft. to the limits of the block. When these

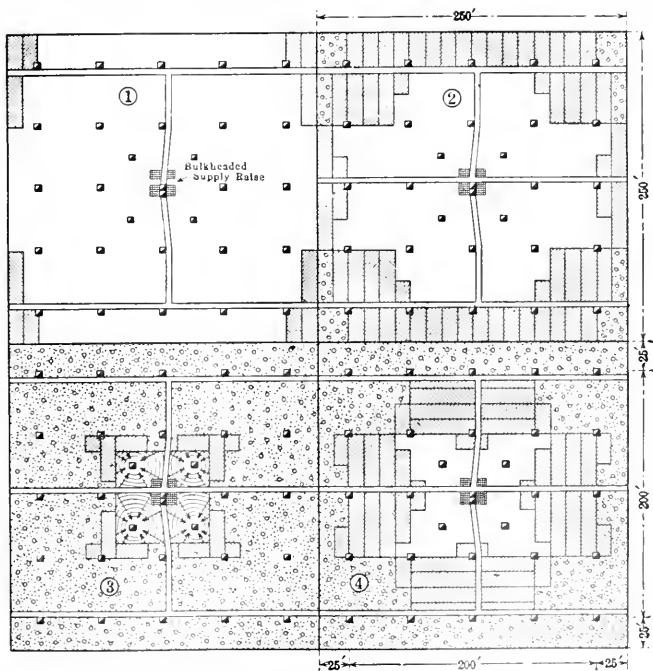


FIG. 1. TO 4. PLAN SHOWING PROGRESSIVE STEPS IN BLOCK METHOD OF TOP-SLICING.

limits are reached, slices are started toward the corners. These slices are timbered either with single sets consisting of two 8-ft. posts and a 12-ft. cap, or with a double set consisting of three 8-ft. posts and two 7-ft. caps, depending upon the ground. The ore is taken to the floor above.

As soon as the first slices have advanced a few feet, second and third slices are started, and also first slices toward the centres of the block limits. Every man who can work to advantage is used and the ore mined with the greatest possible speed.

Where there is a sufficient mat of old timbers in the back to obviate the danger of the capping running into the ore there is no permanent floor laid, the planks used

*Excerpt from paper presented at Arizona meeting of American Institute of Mining Engineers (September 1916).

in shoveling and wheeling the ore being taken up later. Where there is no mat or it is not sufficient, a floor of 2-in. plank spiked to 2 by 10 sills is laid. Formerly 5 by 10 and 4 by 8 sills were used, but it was found that after being subjected to the pressure and heat of a completed stope, a 5 by 10 or 4 by 8 sill seemed to have no more strength than a 2 by 10.

As soon as the timbers in the slices show signs of taking weight, bulkheads are built of old timbers, obtained either from the mat in the back, or from repair-work in other parts of the mine. As soon as possible, the posts are drilled and the slices shot-down.

By the time slicing has started, four drifts have been run to the centres of the sides of the blocks as shown in Fig. 2 and slicing is also done from these. Working as intensively as possible, all ore except the four central pillars is quickly mined-out as shown in the series of illustrations. When the last of this ore is being taken, cross-cuts are driven to incline-raises, put up to about the centre of the four central pillars, as shown in Fig. 3, and slicing continues, working from the outside of the remaining ore to the supply-raise bulkheads first built as shown in Fig. 1, thus completing the stope. By this time, these bulkheads, which are 10 ft. high when put in, have squeezed to from 4 to 6 ft. in height. Upon completion, the stope is shot-down and another may then be started below, though it is best to let the ground settle for a few weeks.

At first thought the criticism suggests itself that this mining method increases the weight overhead as the block approaches completion. But experience has shown that, as a rule, the maximum weight is taken by the timbers at about the time the outside pillars are completed, and as mining progresses a larger proportion of the weight is taken by the bulkheads in the outside slices. At no time does the weight on the remaining ore and the slices still necessarily open get beyond control. These central pillars constitute our cheapest ore, not only because of the pillar raises but because the ground has been fractured by the weight, and 'lifters' are the only holes necessary to break the face.

All drilling is done with plugger-machines, using a water-spray attached to a 5-gal. can. No cars are used in the slices, all ore being shoveled directly into the chutes or wheeled in barrows. Round timber is used almost exclusively in the stopes, because of its superior strength.

Ten feet has been taken as the standard height of a slice. If a greater height is taken the ore breaks from the top of the slicing face faster than it can be removed and the bottom blasted, thus shortly caving the slice. It is possible that later, when a good mat has been formed, sub-level caving may be used but so far, where tried, it has not been successful.

The ventilation of these slice blocks is important because without it, the heat coming out of the mat is excessive and prevents efficient work. It is accomplished by connecting one of the sub-levels below the slicing floor with the discharge end of a 10,000 cu. ft. fan

Openings are maintained from the sub-level to raises through which it is desired to force air.

As a result of the change to the block method of slicing, and to using forced ventilation, the production per shoveler-shift has been raised from 9 to 20 tons, the production per man-shift from 5 to 10 tons.

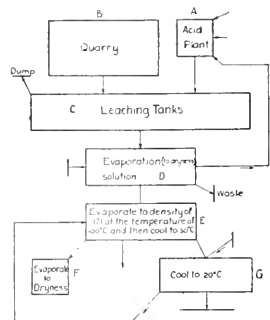
While the details of this method have been fully worked out and a large tonnage of ore has already been extracted by its use, the work to date has to a large extent been preparatory to systematic work for lower lifts. It is not possible to give representative costs, but the following is an estimate of what is expected:

Preliminary development	\$0.035
Haulage development	0.025
Other development (raises, etc.)	0.080
Total development	\$0.140
Stope costs:	
Miners, at \$3.75	\$0.080
Muckers, at \$3.75	0.160
Drills	0.030
Explosives	0.040
Timbering, labor	0.070
Timbering, supplies	0.130
General—bosses, nippers, etc.	0.040
Total stoping	\$0.550
Haulage	0.055
Hoisting	0.040
Pumping	0.005
General underground	0.025
Ventilation	0.015
Engineering and sampling	0.016
Underground lighting	0.004
Mine surface	0.030
Total	\$0.880

OZOKERITE is a mineral wax consisting of a mixture of hydrocarbons, the definite composition of which is not known. In color it varies from black or dark brown to light yellow, but some specimens have a greenish color. It varies from a soft plastic mass to the hardness of gypsum. The melting point ranges from 58 to 80° C. It is valuable for its refined product ceresin which is odorless. Ozokerite is soluble in ether, petroleum, benzene, turpentine, and carbon-bisulphide. Alkalies and the strongest acids have no effect upon it, which makes it valuable for lining vats in which acids are held or used in treatments. In addition to resisting the acids it is unequalled for water-proofing. The list of its uses is a long one, but its most important use is probably in the manufacture of electrical articles. Being an excellent non conductor it finds wide use for the insulation of electric wires and in the manufacture of insulators. It occurs as lenses or fillings of small fissures varying from the thickness of a mere film to veins several feet in width. Extraction from the gangue is simple, requiring a small amount of heat to melt the wax which can then be easily removed. Until recent years the chief supply came from Austria, but since the War, interest has been stimulated in the deposits of this country which are being profitably exploited.

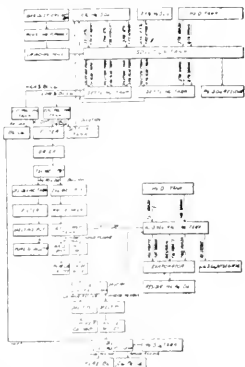
RECENT PATENTS

1,182,668. PROCESS FOR TREATING ROCK CONTAINING ALKALI METALS. Frédéric Ludwig Firebaugh, Berkeley, Cal. Filed April 30, 1915. Serial No. 24,882.



1. The process of treating rock containing sodium and potassium which consists in leaching the rock with sulfuric acid, evaporating the resulting solution to dryness, continuing to heat the evaporated mass to decompose the non-alkali sulfates, adding water to the so-heated mass to dissolve the sodium and potassium sulfates, then concentrating the so-formed solution of sodium and potassium sulfates by evaporation, then cooling the concentrated solution to separate by crystallization the maximum amount of potassium sulfate from the sodium sulfate, then adding to the remaining solution more water and cooling the same, so that the sodium sulfate can be separated by crystallization without crystallizing the potassium sulfate present.

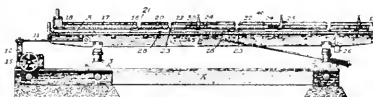
1,194,438. PROCESS FOR SEPARATING METALS. Royal H. Stevens, Salt Lake City, Utah, assignor to United States Smelting, Refining & Mining Company, Portland, Me., a Corporation of Maine. Filed Nov. 20, 1912. Serial No. 732,402.



1. The process of separating metals from ores and like material containing cadmium, bismuth, copper, lead, tellurium, arsenic and similar metals consisting in oxidizing the ore and dissolving in sulfuric acid, electrolyzing the resulting sulfates at a low voltage to separate bismuth and copper therefrom, electrolyzing the solution remaining from the first electrolytic

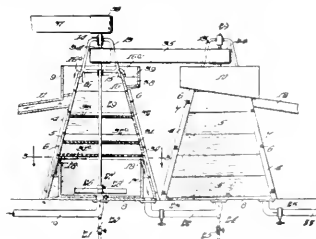
bath at a different voltage to deposit a cadmium residue therefrom, fluxing and melting said residue to separate tellurium, casting the bullion resulting from the reduced residue, electrolyzing the bullion in a cadmium electrolyte to separate pure cadmium, separating and melting the cadmium sludge resulting from the bullion electrolysis, and casting into plates, re-electrolyzing the cadmium sludge plates in a cadmium electrolyte to abstract pure cadmium, separating and melting the bismuth residue from the cadmium bullion electrolysis, and casting into plates, electrolyzing the bismuth residue plates in a bismuth electrolyte to separate pure bismuth from a copper, lead and cadmium residue.

1,185,129. CONCENTRATOR. Charles F. Paige, Oakland, Cal., assignor of one-third to Adolph W. Jones and one-sixth to Harry B. De Mooy, Oakland, Cal. Filed July 8, 1915. Serial No. 38,701.



1. In a concentrator, a table, a flow surface formed on the table over which the pulp is adapted to travel, means for shaking the table to cause the pulp to travel in a certain direction, a cover section having a plurality of discharge openings formed therein inclosing the flow surface of the table, and a skimming plate secured to the cover section adjacent to each discharge opening to carry the light material up through the opening and up over the top of the cover.

1,195,453. ORE-CONCENTRATOR. William Fagergren, Salt Lake City, Utah, and William D. Green, Butte, Mont., assignors, by mesne assignments, to Metals Recovery Company, a Corporation of Maine. Filed Aug. 12, 1913. Serial No. 784,336.



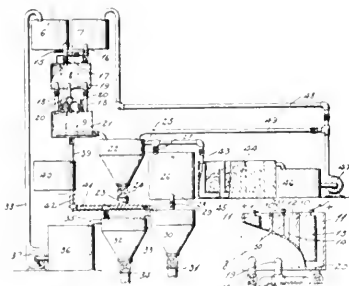
1. In an ore concentrator, the combination of a tank, a receptacle located within said tank and provided with a wall having a continuous edge from which ore materials may be discharged, means for introducing within said tank and within said vessel ore pulp or the like, means for admitting air into said receptacle, a dasher located within said receptacle for the purpose of agitating said ore pulp and said air, a plurality of baffle floors located at different successive levels within said tank and provided with openings, and means for discharging gangue and water overflowing from said receptacle within said tank and means for discharging concentrates from the top of said tank.

1,197,589. PROCESS OF TREATING ORES. Raymond F. Bacon, Pittsburg, Pa., assignor, by mesne assignments, to Metals

Recovery Company, a Corporation of Maine. Filed June 28, 1915. Serial No. 36,638.

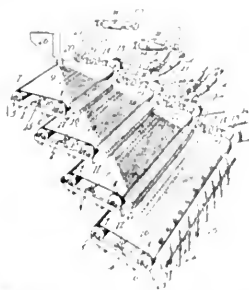
1. The method of effecting the separation of non-sulfid ores from associated gangue, which comprises subjecting the mixture, in a finely divided condition, to the action of hydrogen sulfid in the presence of sulfur dioxide and thereby converting the metal values into sulfids and forming colloidal sulfur within the mixture, and subjecting the resulting mixture to a flotation treatment; substantially as described.

1,195,616. METHOD OF EXTRACTING METALS FROM THEIR ORES. Henry B. Slater, Riverside, Cal. Filed Sept. 2, 1913. Serial No. 787,598.



1. The method of extracting copper from its ores which consists in subjecting the ore to the action of a solution containing alkali metal chlorid, and a metallic chlorid capable of reduction to a lower chlorid, together with hypochlorous acid, then precipitating the copper from the solution, and then subjecting the solution to the action of free chlorine in the presence of a metallic hydroxid to regenerate the solution containing hypochlorous acid together with a metallic chlorid capable of reduction to a lower chlorid for use in a cyclic manner.

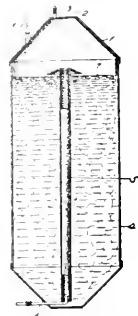
1,196,917. PROCESS OF AND APPARATUS FOR SIZING OR CLASSIFYING COMMINUED MATERIAL. Henry M. Sutton, Walter L. Steele, and Edwin G. Steele, Dallas, Tex. Filed Feb. 5, 1914. Serial No. 816,754.



1. The process of sizing material, consisting in transporting material composed of grains of varying size, on a series of successive supports, inclined transversely to the direction of transporting movement, and subjecting said material to gravitative impulses adapted to deviate the components of said material from the direction of transport in proportion to their respective size, progressively varying said gravitative impulses upon the successive supporting surface, and separately collecting the separated size of material from the last supporting surface.

1,198,611. METHOD OF EXTRACTING PRECIOUS METALS FROM THEIR ORES. Thomas R. Cowe, Axtel, Colo. Assignor to

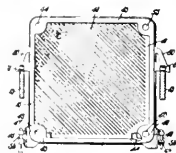
The Portland Gold Mining Company, Colorado Springs, Colo., a Corporation of Wyoming. Filed Mar. 2, 1915. Serial No. 11,603.



1. A method of extracting precious metals from their ores, which consists in placing finely ground ore in a cyanid solution, blowing into the mixture under pressure a constantly renewed supply of fresh atmospheric air, while maintaining the mixture under a pressure greater than atmospheric pressure.

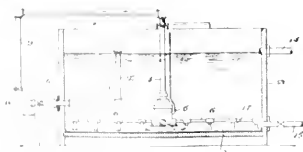
2. A method of extracting precious metals from their ores, which consists in placing finely ground ore in a cyanid solution, blowing a constantly renewed supply of fresh atmospheric air into a mixture, and restricting the escape of said air, so that the mixture is maintained under pressure greater than the atmosphere.

1,191,949. FILTER. Charles D. Burchenal, New York, N. Y. Filed Mar. 10, 1916. Serial No. 83,280.



1. A filter, comprising alternating cells and plates and filtering mediums between them, the cells and plates being provided with a longitudinal supply passage opening into all the cells, and the cells and plates being provided at opposite sides with longitudinal outlet passages, each plate being connected at one face with the outlet passage on one side of the filter and each plate having its other face connected with the outlet passage on the other side of the filter.

1,198,086. PROCESS OF EXTRACTING PRECIOUS METALS FROM THEIR ORES. Albert E. Vandercook, Alameda, Cal., assignor of one-half to Leslie B. McMurtry, San Francisco, Cal. Filed Oct. 21, 1911. Serial No. 868,159.



1. The process of recovering precious metals from a mixture of sulfid ore and metallic particles with a sodium or potassium cyanid solution, which consists in agitating the mixture in the presence of mercury whereby a double cyanid of mercury and sodium or potassium is formed which removes the alkali from the solution.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

MEXICO CITY, MEXICO

ABSTRACTS OF RECENT DECREES AND COMMENTS THEREON.

During the summer two important decrees for the mining industry were promulgated by Carranza. The first was drafted on May 1, but part did not go into effect until July 1; it concerns taxation. The second decree began to operate on August 15, and affects the property rights of foreigners. A condensed translation of the first or taxation decree reads as follows:

PERMANENT ARTICLES. ARTICLE 1. There still remain subject to the Stamp Tax all metals for export, whether originally produced at home or abroad. This tax will be levied as follows:

A. On metals that are exported in the form of mineral or earth, cyanides or sulphides, smelting residue, or in any other form in which they are mixed with non-metallic substances, as follows: Gold and silver, at rate of 10% *ad valorem*, other metals at rate of 5% *ad valorem*. The Secretary of the Hacienda (Treasury) will fix each month the values of the metals for taxation from the quotations in foreign markets.

B. On metals that are reduced to pure metals or alloys at home the above rate will be lessened by 20%, whatever the assay of the product.

ARTICLE 2. There will be no Stamp Tax levied on the following:

A. Refined gold, which is brought to the mints for coinage, and which is presented at the Federal offices in exchange for silver money at the rate of 75 centigrams of pure gold for one peso, (P1).

B. Current gold or silver coins, whether native or foreign.

C. Silver that is exported in products not exceeding a content of 250 grams per ton. Such products may be in the form of lumps, earthen, or powders; and may be in their natural state, or as concentrates, sulphides, cyanides, or smelting residues.

D. Silver and gold imported in any of the forms of the last paragraph, or partly refined, which may be exported within the four following months in cakes, ingots, or bars, after having been subjected to metallurgical treatment in Mexican works.

E. Gold and silver which is used in national industries.

F. Samples of natural minerals that are exported according to administrative regulations.

G. Ores of copper with less than 3% copper; ores of lead with less than 10% lead; and ores of zinc with less than 15% zinc.

ARTICLE 3. Assay-fees will only be charged for assays made at the request of those interested, by legal rule, or by administrative order; smelting fees only when a lack of homogeneity of the bars or pieces requires smelting for a proper valuation; and refining and parting-fees only when such operations are performed in Government offices at the request of the interested parties. The fees just mentioned will be fixed according to the cost of the operations, and from a schedule issued by the Department of Hacienda.

ARTICLE 4. Metallurgical enterprises will still be subject to the common Treasury regulations in all their operations.

ARTICLE 5. The special stamps that existing laws require for the titles of mining property will be at the rate of P10 Mexican

gold for each pertenencia (1 pertenencia = 2.47 acres) titled, irrespective of the kind of mineral denounced.

ARTICLE 6. The annual tax-rates for mineral land will be:

For gold and silver lands: for 1 to 10 pertenencias at the rate of P6 each; 11 to 50, P12; 51 to 100, P18; and 101 or more, P24 each.

For other mineral lands: for 1 to 50 pertenencias, P6; 51 to 200, P12; 201 to 500, P18; 501 or more, P24 each.

ARTICLE 7. The graduation of the rates will apply when the pertenencias belong to one owner and lie in the same mining district.

ARTICLE 8. The States will not assess mining at more than 2% of the gross mineral output, and will except ores of iron and quicksilver.

ARTICLE 9. There will be no import tax on the following substances, when they are imported for treating ores: zinc, whether in bars, filings, grains, shavings, or small sheets; sulphur, alkaline cyanides, sodium hyposulphite, and nitrates of potash or soda.

ARTICLE 10. All sums due the Exchequer under this decree must be paid in national gold coin.

TEMPORARY ARTICLES. ARTICLE 1. This decree will begin to apply at once, excepting the rates fixed in Article 6, which start only on July 1, 1916.

ARTICLE 2. Hereby are annulled the decrees of March 25, 1905; of March 1, 1915; the articles No. 2, 4, 10, 11, and 12 of the decree of March 27, 1907; and any remaining rulings that may be opposed to this decree.

ARTICLE 3. Any owners who owe taxes on mineral pertenencias will settle them as follows in gold:

A. Debts previous to March 1, 1915, will be settled at the then prevailing rates plus 200% of penalty.

B. Debts covering the four months from March 1 to June 30 of 1915 will be settled at the rate of P6 per pertenencia annually for the first 25 and at the rate of P3 each for the excess above 25 pertenencias, all plus 100% of penalty.

C. Debts covering the four months from July 1, 1915, to October 30, 1915, will be settled at the rate of P6 annually per pertenencia, whatever the number, plus 50% of penalty.

D. Debts covering the four months from November 1, 1915, to February 29, 1916, will be settled at the rate of P8 annually per pertenencia, plus 25% of penalty.

E. Debts covering the four months from March 1 to June 30, 1916, will be settled at the rates of the decree of March 1, 1915, with no penalty.

ARTICLE 4. Hereby is granted a non-extensible period, ending June 30, 1916, in order to pay the annual taxes due until February 29, 1916; a failure to pay will mean *caducidad* (annulment of title).

ARTICLE 5. For once only and solely for the debts due until February 29, 1916, there is allowed the option of payment either in gold or in its equivalent in credit money at the rate fixed by the Monetary Commission.

ARTICLE 6. Any debtors who, previous to March 1, 1915, may have paid any sums beyond those prescribed in these transitory articles, may have such excesses credited on subsequent payments.

ARTICLE 7. The tax of 5% on base metals, mentioned in A of ARTICLE 1, will apply to copper when its New York cash price

is less than 25c. per pound. When its price is between 25 and 30c. the tax will be 6%, and when beyond 30c., 7%.

ARTICLE 8. The gold and silver products which, without leaving the country, may have satisfied the Stamp Tax of the decree of March 1, 1915, will pay when they are exported the quantity still lacking to cover the rates fixed by this decree.

CONSTITUTION AND REFORMS. Given in the National Palace, Mexico City, May 1, 1916, by V. Carranza, First Chief of the Constitutionalist Army, to Luis Cabrera, Secretary of State and of the Hacienda.

The second, or foreigners' decree reads as follows:

PREAMBLE. Considering that our basic laws give to strangers the same rights as Mexicans, it is natural and lawful that the former also assume the same obligations, for the liberality of our democratic institutions should not reach the extreme of giving to foreigners, owning property here, a better judicial position than Mexicans, as has hitherto sadly been the case. This would happen if foreigners, besides enjoying the rights granted by Mexican laws, should be allowed to plead and make complaints to their respective home governments. The First Chief of the Republic has therefore used his extraordinary powers in order to establish the following decree throughout Mexico:

ARTICLE 1. Any foreigner who wishes to acquire in Mexico public lands, mining claims, Federal waters, or permits for the exploration or exploitation of natural resources, such as forests, petroleum, fisheries, etc., must present a written renouncement to the Secretary of Foreign Relations. This document must make a formal and final declaration that, as an owner or concessionaire, and for all the effects and relations of the property to be acquired, the foreigner must renounce all his rights as such to ask protection from or complain to his home government. Foreign companies are also incompetent to acquire rights over the class of property mentioned in this circular, until they submit to Mexican laws and make the above renouncement.

ARTICLE 2. It will be an indispensable pre-requisite before the Secretary of Fomento can accept any denouncement or petition about this class of property, however trivial, that the foreigner present at the beginning a certificate from the Secretary of Foreign Relations showing that he has made the above renouncement. Lacking this certificate the petition will be rejected and will have no legal force no matter how much it may be agitated.

In all titles and permits delivered by the Department of Fomento and in all contracts or public documents before a notary concerning this class of property, a clause certifying the above renouncement must be inserted or the writing will be legally void.

ARTICLE 3. In all applications already made by foreigners, which are now in transmission before the Department of Fomento or its branches, concerning this class of property, the transmission will be suspended immediately and will not be resumed until the presentation of the above certificate of renouncement. If this last is not presented within the space of four months from the date of this decree, the petition will be deemed abandoned, and the attendant applications will be filed without allowing the interested party any right of further appeal.

Constitution and Reform. Mexico City, August 1, 1916. The Under-Secretary of the Department of Fomento, Pastor Rojas.

This decree, connected with the one described in my letter of June 19 and July 15, is contained in number 1. The really important new item in this decree is the export and output tax on metals, a tax on mineral income, and a renouncement of diplomatic protection. Under this the export tax is fixed at 2%, not only on 99% of the metal, while the output tax on all metals was at 1% for the State

plus 1% for the Federation. The new rates thus mean nearly a tripling of the old schedule, though this is not due all to Carranza, as Huerta in 1914 raised the tax on gold to 10%. These bullion taxes, of course, affect only the few mines in operation, and all but the poorest of these can probably afford to pay them, owing to the high price of all metals except gold. Under Huerta the great gold mines at El Oro were able to support the 10% bullion tax, and can therefore do so now, provided they can get adequate protection from bandits, and regular railroad service. However, a tax on the gross output is not a fair tax—only a tax on net profits can be that—and the more the rate is advanced the more onerous becomes the burden on low-grade mines.

A mistaken view seems to prevail in the United States regarding the new taxation of mineral land, which policy is indeed one of the few genuine reforms inaugurated by the Carranza party. The Diaz rates of ₧6 (Mex.) per pertenencia up to 25, were grossly inadequate as a defense against forestalling, as they were equivalent to only \$1.20 U. S. and 60c. per acre respectively. The ancient Mexican policy of requiring continuous work, as the requisite to holding mines, was finally abandoned in 1892, and replaced by a land tax which was so trivial as to put the 'land hogs' into clover.

By 1910 there was perhaps not a district in Mexico where a prospector could find any ground unoccupied that had mineral possibilities. It was common then for great companies or rich individuals to hold 1000 to 5000 acres of mineral land in one district while seldom working 5% of their holdings. Wherever Carranza can protect the operator properly, the new rates are none too high to discourage forestalling—that curse of the United States mining industry also. Where the prevailing anarchy makes production impossible, there and there only has the land-holder just cause for complaint at the new policy of taxation.

The decree of renouncement may be looked at from two view-points: The preamble is certainly plausible in claiming that Mexicans should enjoy the same right to the use of their own natural resources as do foreigners. However, the right of diplomatic intervention could hardly mean more than securing justice for the foreigner according to Mexican law and in view of the rotten condition of the Mexican courts for generations, a foreigner can hardly be blamed for wishing all the guarantees possible. Whatever Carranza's object in requiring renouncement, whether it be merely a sop to placate his anti-foreign following or a step toward complete exclusion of foreign enterprises, it seems certainly an inopportune time to issue such a decree. If Carranza really means to comply with his treaty obligations and to treat foreigners fairly, the decree seems entirely unnecessary. It is likely that Carranza will find his decree a boomerang that will merely strike another blow at the decrepit structure of 'Constitutionalism,' for which his party claims to stand sponsor, and which was nearly wrecked by the dreadful financial decrees of last June.

The fact that the decree of August 15 was followed within a month by the decree of September 15* offers little hope to foreigners as to the benevolence of the only protector they will have remaining after a renouncement of their own diplomat. The provisions of the September decree leave a mine-owner at the mercy of the bureaucrats of the Department of Fomento, these may prescribe as they choose concerning the minimum number of men to be worked 'continuously' on his property. Even when bandits and lack of transport render any operation impossible, the mine-owner will still forfeit his mine automatically unless he has the luck to get from the bureaucrats a permit to excuse his inactivity. In view of the anarchy prevailing throughout Mexico, this decree will give Carranza a goodly opportunity to confiscate 90% of foreign-owned mines before this end—should he choose to do so, even supposing the

*M. & S. P. Oct. 7, 1916, p. 537.

decree is carried out with all due respect to legitimate interests, yet the gross ignorance of the Fomento bureaucrats regarding practical mining would render it an unmitigated nuisance to all operators and a ruinous burden to not a few.

In this connection it is interesting to mention the program of the anti-foreign party so charmingly portrayed by Lic. Andres Mollino Enriquez in his 'Problemas Nacionales.' As this book was published during the regime of the capital-hunting Diaz, it could not detail the scheme as it affected the property of foreigners, but merely gave what it proposed regarding their persons. First, all immigration of laborers was to be forbidden; next, foreign factory-foremen would be admitted only for a long enough stay to instruct Mexican successors in their duties; and finally, no foreign doctor, engineer, or other intellectual could practise his profession in Mexico until he had taken out citizenship papers.

Enriquez' frankly-expressed plan is to make Mexico a close preserve for the benefit of the existing Spanish-Indian mestizos, the pure Indians to be assimilated by inter-marriage. His original following consisted of middle-class youths inspired by an insane jealousy and prejudice against their foreign rivals for employment, not realizing that their own irresponsibility, dishonesty, and medieval education made them unworthy of anything but inferior positions with foreign companies. In fact, nearly all big business, such as manufacturing, mining, and wholesaling, has always been in foreign hands owing to the inefficiency of the native middle-class. During the revolution the anti-foreign faction has, for the first time, been allowed to extend its propaganda freely among the town-artisans and the armies, until finally a complete control of the Carranza government apparently has been achieved.

The fact that so many Carranza generals and politicians have made revolution a business and risen from poverty to affluence since 1912 is of sinister import to foreigners, for such keen appetite for loot will never be finally appeased until it has fed freely on the two billions of foreign-owned property. But the same fact militates against the plans of the Magon anarchistic propaganda, explained in *Regeneration* of Los Angeles (see my letter of January 29), which proposes to take over all property in Mexico, whether native or foreign, and administer the country as a communistic state for the benefit the peons. The suppression of the Magon propaganda, as exemplified by the orators of the I. W. W. of Mexico City last February, showed the difference in ideals between the Carranza ring and Magon. Evidently only those "practical" from long experience in Carranzista interventions will take charge of all the foreign property to be confiscated in the future as they have done of the reactionary property in the past, and idealistic dreamers of the Magon type will be given nothing for their peon followers except some decree forbidding immigration.

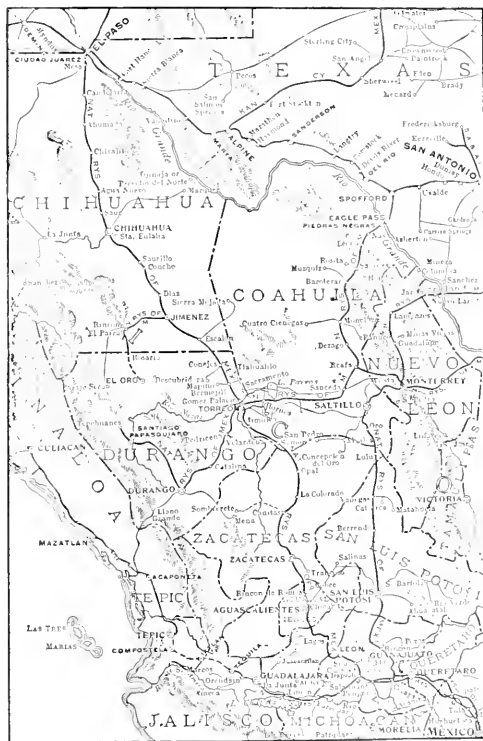
MAZATLAN, MEXICO

CONDITIONS IN THE WEST COAST DISTRICTS.

Train service has been resumed between Mazatlan and Nogales on an irregular schedule. The trip now requires four days where formerly it was made in a day and a half. Trains run only during the day-time owing to the bad condition of the road-bed, which makes night-travel exceedingly dangerous. Nearly all of the work expended on the railroad during the last four years by the various 'istas' has been in destruction rather than construction. Heavy rains of the past few months have washed away a number of the flimsy wooden bridges that had replaced the substantial concrete and steel structures long since made useless by the different factions in their military movements.

Most of the Americans who abandoned their properties last June have returned and are working their mines. The prin-

cipal mines at work in this district are the Potrero Mining Co., at Potrero, the Guadalupe de los Reyes, the mines at San Dimas, Durango, and the Minas del Tajo, at Rosario. The famous old Panuco mine, which has been worked by the Carranza government for the past two years, was flooded by the recent rains and has been abandoned. It is said that the de facto Government is willing to return the mine to the owners if they renounce their claims to indemnity. Also that the Government is willing to release the San Jose de Gracia mines



WEST-CENTRAL MEXICO.

to the former owners on the terms that they pay 30% of the gross output. It is impossible to work under such conditions with the guarantees that the present Government can furnish.

The issues of *infalsificable* bills that were to replace all the previous paper-issues have fallen into ill repute and are now exchanged at the rate of thirty to forty for one American dollar. It is surprising the large amount of American money that is in circulation. All transactions of any magnitude are done with the American dollar. Even the poorest peon calculates his values in terms of American money dividing the paper peso by 30 or 40 according to the prevailing rate of exchange. There are rumors from Mexico City of a silver coinage to take place in the near future for the government evidently realizes after this last failure of the *infalsificables* that the people are tired of paper and want a medium of exchange of more purchasing power. Meanwhile Carranza continues to issue decrees, no longer one at a time but in series, while the politicians and military leaders rob the people and prey upon the mining industry.

Fear of starvation due to the scarcity of corn this summer, caused a great amount of the cereal to be planted. There are prospects of a good harvest.

SUTTER CREEK, CALIFORNIA

SPIKE SITUATION AND CLASH AT THE SOUTH EUREKA.

The following notes were written on October 15:

The expected re-opening of the South Eureka and Central Eureka mines here on the 10th was prevented by striking miners gathering, nearly 200 strong, on the road leading to the mines and ordering the men not to work. The Sheriff and a number of deputies were unable to disperse the crowd, and when W. G. Snyder, the district attorney, appeared on the scene, and had the president of the Union explain to the strikers that it was unlawful for them to gather there for the purpose of obstructing the road and that if they did not disperse they were liable to arrest, the warning was received with derisive smiles from the men. Sheriff Layot, on his return to Jackson, notified the Governor's office of his inability to handle the situation, with the result that the State labor commissioner, John P. McLaughlin, and J. J. Kelly, one of his special agents, are now here, endeavoring to bring about an amicable adjustment of the difficulties existing. Union pickets have continued to warn miners, engine-men, and pump-men from working, 15 or 20 men waiting along the road up Sutter hill at times when the men ready to return to work would be going on shift. On Wednesday night about 7 o'clock a number of men obstructed the road when James Kerfoot, one of the Central Eureka engine-men, drove toward the mine in his car, and one of the men, Obron Mijovich, was run over, sustaining injuries from which he died the following morning. Kerfoot proceeded to the mine. Fearing violence to Kerfoot, the Sheriff organized a posse, including a number of armed men from Sutter Creek, Jackson, and Amador City, possibly a hundred in all, and marched up the hill to the mine. The men, some of whom were said to have threatened to avenge the death of their comrade, had all disappeared by the time the citizens under the Sheriff reached the mine; they then accompanied the Sheriff, with Kerfoot, to Jackson. At the inquest on Mijovich's body next day, the witnesses examined were unable to name the man driving the car, although one identified him as a Central Eureka engineer, so the verdict of the Coroner's jury was as follows: "Obron Mijovich's death was due to injuries sustained by being struck by an automobile on the public highway at the hands of an unknown party or parties." Great excitement prevailed during the night and day following the accident, and the deceased miner was yesterday given the largest funeral ever witnessed in Amador county. About 700 Union miners joined the procession, which lends color to the Union's claim that their membership has greatly increased since the strike was declared on the 19th of last month. When the engine-men and pump-men were not permitted to keep the mines unwatered, the South Eureka company threatened to demand reimbursement from the County for damage resulting from a lack of protection. About a dozen men from outside points have been provided for at the South Eureka mine, bedding and provisions for their use having been placed on the ground, but it is understood these men are acting as guards and not as pump men or engineers. The Union has signified its willingness to have the engine-men and pump-men return to work, provided they are only required to keep the mines unwatered, and it is understood that most of the mine-owners have agreed to this arrangement, and desisted from the extensive repairs that has been in progress since the strike began, but the Sutter Creek operators have not yet met the demands of the Union in this regard and work is at a standstill, including pumping at the South and Central Eureka. John Martin and H. Malloch of the South Eureka mine, and V. S. Walsh of the Central Eureka, have been here during the week, and they held a meeting yesterday with other operators, but without definite result, and conjecture is as to what the next move will be.

Up to October 18 there was nothing new to report.

PLATTEVILLE, WISCONSIN

ZINC-ORE CONDITIONS DURING SEPTEMBER.—ORE STOCKS.—NEW

PLANTS.—LEAD, PYRITE, AND CARBONATE CONDITIONS.—PRODUCTION.

During September there were new records in the zinc-lead region, in spite of conditions that tended to retard both development and operation. Prices for zinc ore were at a standstill all the month, the standard 60% product and premium grades holding steadily at \$56 per ton, with the range down to \$50 for concentrate as low as 50% zinc-content. Many prominent operators personally interviewed earnestly declared that the high cost of supplies and labor, both skilled and unskilled, made these prices no more profitable than the \$40 standard, when other conditions were normal. Toward the close of the month fair gains in the price of spelter and a sturdier tone in the market served to influence ore prices, and the range was raised to \$58 per ton for 60% base, and the range down to \$50 was increased to include ores containing no less than 54% metal. The discrimination against producers of low-grade ore for the past three months was thus further emphasized, as it brought ore of this character into still greater disrepute. The result was evident before the month was over, several producers of long standing suspending operations, giving as the reason the low prices for ore; but to be more exact, because there was absolutely no demand for low-grade ore from independent operating mines to zinc-ore refineries well supplied with ore from mines operated in combination with separating plants.

A large reserve of zinc concentrate was on hand in the field at the close of the month, the Highland, Linden, Mifflin, and Platteville districts between them holding 6000 tons. In the other districts and south of Platteville, most of the large mines are owned by foreign corporations, who divert their output to refineries operated in connection with them, and it is here that little ore is carried over at the end of a month. But there are also many independent companies in this part of the field, which accounted for another 1500 tons.

Ideal weather conditions, copious rains at intervals filling mill reservoirs, a return to the mines of many farmers who have garnered their crops and who work in the mines during the winter, good roads, and steady prices contributed to an exceptionally heavy production of ore in September, and shipments of high-grade ore out of the field to smelters were higher than for any single month yet reported.

Decided gains were recorded in the price of lead ore, offerings at the beginning being as low as \$60 to \$65 per ton for 80% base, but the price mounted higher from day to day and closed the month in advance of \$75 per ton. It was thought that this price would bring out most of the ore held, but it failed to do anything of the kind; and producers of lead ore, usually a keen crowd, held onto their ore in hopes of even better prices. It was conservatively estimated that 1500 tons of lead concentrate was on hand at the end of September.

Shipments of iron pyrite increased considerably, although no increases in offerings were admitted. The reserve had grown to such proportions at all the zinc-ore refineries that holders of pyrite were glad to get some of it out of the way, prices concerning them little. There is still held in reserve over 15,000 tons, and no great amount will be worked-off at an early date.

Producers of carbonate of zinc ore received no attention from buyers.

Deliveries of ore during September were as follows: 30,685 tons of ore, 1.5 tons of lead, and 1276 tons of pyrite. These are the highest figures ever attained in this field for deliveries of zinc product. The actual production of crude concentrates was also the highest, being over 25,000 tons; while shipments of high grade ore direct to smelter broke all records with a total of 15,000 tons.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

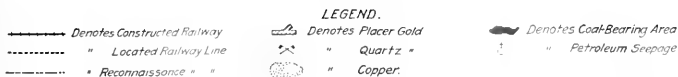
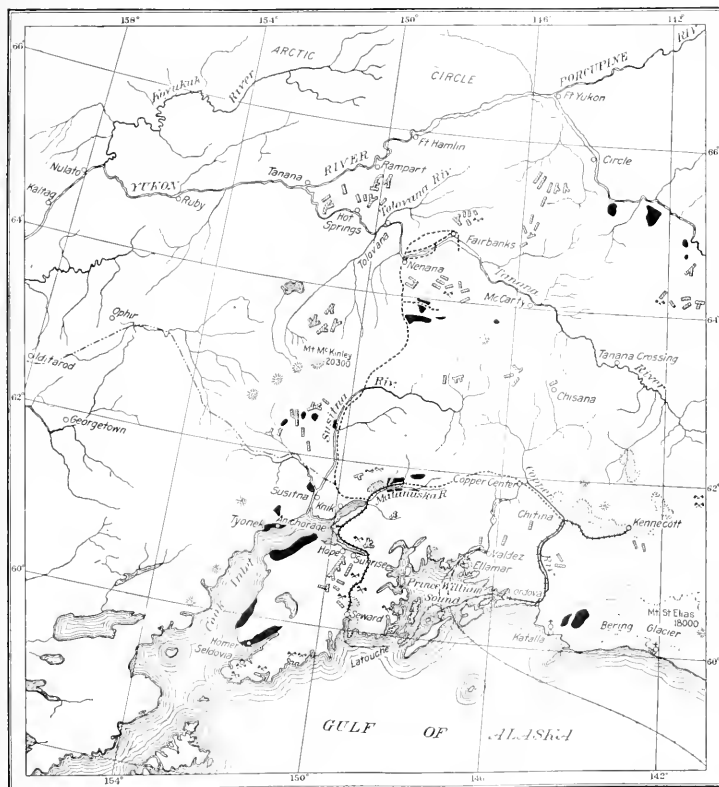
The report of the Alaskan Engineering Commission, with maps, charts, and profiles, covering the period from March 12, 1914, to December 31, 1915, has been issued. One part con-

sists of a foreclosure sale at New York on October 18. The purchasers will then have a clear title to the property. It was thought that the United States Smelting, Refining & Mining Co., which has spent a great deal of money on the mine, would be the buyer.

Commenting on the present situation of the Alaska Gold Mines Co., the *Boston News Bureau* says that it seems to be the settled conviction of those closest to the management, that for several months at least nothing need be expected in the way of operating returns better than those now being reported. During the first 10 days of September the average assay-value of the ore was \$1.51 per ton, but for the entire month the average dropped to \$1.39 per ton, indicating rather poor results for the last 20 days. There is a large accumulation of low-grade ore broken in the upper-level stopes, and this material must be removed and milled—as there is a small profit in the operation—before opportunity is given for opening stopes in the lower levels in a manner which it is believed will yield a larger return per ton of ore treated. Officials of the company are convinced that the original scheme of opening the stopes was a mistake, in that it resulted in an excessive caving of the hanging-wall material, which was low in grade; but as there is over 2,000,000 tons of this low-grade ore already broken in the upper levels, some time must elapse before any new scheme of mining can be put into effect. The new plan of ore extraction will probably involve an additional cost of 5c. per ton. All construction work at the property has been completed. Present indications, however, are that the mine will never be able to treat the expected tonnage of ore that will yield \$1.75 per ton, so that early estimates as to prospective profits must be revised downward.

ARIZONA

Celestite and strontianite, the strontium sulphate and strontium carbonate respectively, are discussed by F. L. Culin, Jr., in Bulletin 35 of the Arizona Bureau of Mines. Strontium salts are used at beet sugar refineries, fireworks, and in medicine. The metal belongs to the same group as calcium and barium. The minerals are found in limestone and gypsum. The demand is small and fluctuating, and high-grade ore receives only \$2.50 to \$4 per ton. In Arizona, 15 miles south of



SOUTH-CENTRAL ALASKA SHOWING RELATION OF RAILWAYS TO MINERAL DEPOSITS.

sists of 216 pages of profusely illustrated data, describing the route of the line now under construction. There are in a separate pocket 18 large maps. A great deal of interesting matter deals with railroad construction and difficulties encountered. Resources and towns of the country tributary to the line are detailed. Alaskan residents should secure a copy of this report.

JUNEAU. Shares of the Ebner Gold Mining Co. were to be

Gila Bend, in Maricopa county, celestite occurs in sedimentary series associated with gypsum, sandstone, and conglomerates.

(Special Correspondence.)—The Desert Power & Water Co. is now within 12 miles of Chloride with its high-tension line. Work is under way from both ends. Two hundred houses are wired.—The Schenectady is putting in a compressor and drills.—Rich copper ore has been found in the Weaver district by George W. Lynch; also on adjoining claims by W. C. Richings and C. E. Southworth.—The Keystone found rich ore on the 399-ft. level. There is nearly 8 ft. of shipping ore on that level.—The Hidden Treasure has just finished installing a compressor and drills. It has 300 ft. more to drive through granite to cut the large vein at a depth of 500 ft. W. B. Twitchell of Ray is one of the principal owners.—Concentrates at the Arizona Butte assay 12 oz. silver, 66% lead, and \$45 gold per ton. The new mill is working perfectly.—Senator Guggenheim is about to take over the Golden Hammer, which has a splendid showing. The adit opened the vein for 100 ft.—Burros are being used to pack an initial shipment of 250 tons from the Black Jack to the railroad here. Ore exceeds \$100 per ton.—The Guggenheims have completed sampling the Payroll, and it is understood that the deal is about closed.—The Georgia Mining Co. has started sinking, and is down 100 ft. Drilling will commence at 300 ft.—Molly Gibson-Chloride is being unwatered and the shaft repaired; likewise the Hercules and Distaff.

Chloride, October 10.

CLIFTON. In *Economic Geology* for August-September, Louis E. Reber, Jr., discusses mineralization in the Clifton-Morenci district. The paper covers 45 pages, and is well illustrated, especially with microphotographs. Most of the ore-minerals occur in disseminated particles or veinlets in porphyry, though usually associated with some larger veins; and the orebodies owe their commercial value to chalcocitization by the process of secondary enrichment. The country rocks are pre-Cambrian granite, Paleozoic and Cretaceous sediments, and the younger Intrusives.

RAY. Reserves of the Ray Hercules mine are now estimated as 10,000,000 tons of 2½% copper ore. At a depth of 675 ft. native copper has been seen in good quantities. The shaft is being deepened at the rate of 5 ft. daily. Three churn-drills are prospecting. A 2000-ton mill has been ordered instead of 1000 tons' capacity as formerly contemplated.

ARKANSAS

YELLVILLE. The output of zinc ore during September was regular, and totaled 80 carloads.

CALIFORNIA

There have been 550 new oil-wells started in California since the first of this year, according to reports made by operators to the State Mining Bureau. The report for the week ended October 7 shows eleven new wells, about equally distributed between the San Joaquin and Southern fields. Eighteen wells were reported ready to test for water shut off, 3 to deepen or re-drill, and 1 abandonment. The first annual report of State oil and gas supervisor, R. P. McLaughlin, covering the last fiscal year, has been compiled for the State Printer and will shortly be ready for distribution. It will contain a financial statement and summary of the work done by the Department, together with a detailed list of all wells passed on. The report explains general methods that must be followed by oil operators in order to protect their lands and extract the maximum amount of oil, special mention being made of the concerns at present following such methods.

The U. S. Geological Survey has issued U. G. Yale's Mines Report of 10 pages on the gold, silver, copper, lead, and zinc output of California during 1915. From 605 mines from which 3,967,779 tons of ore was extracted, the yield was

\$22,442,296 gold, 1,678,756 oz. silver, 40,751,625 lb. copper, 4,579-245 lb. lead, and 13,094,032 lb. of zinc. The total value was \$32,263,841. All totals were considerable gains, while the value was \$6,553,199 more.

ALLEGHANY. There are now 50 stamps crushing ore on Kanaka creek, the 10 head at the El Dorado being the newest.

FORBETOWN. An Italian syndicate is reported to have bought 12 claims lying north-west of the old Gold Bank mine. An adit is to be driven from the south fork of the Feather river to explore the ground.—At the Southern Cross mine, owned by Rosenthal of San Francisco, a flotation test-plant is at work.—The Carlisle mine is being drained in charge of Mr. Miller.—Activity is in progress at the Campbell, Denver, and Forbestown Consolidated mines.

GEORGETOWN. The Georgia Slide mine is to be further developed, and it is proposed to erect a plant to treat a large quantity of hydraulic tailing in Canyon creek.

It is said that the company working the Georgia Slide mine is unwatering the Beebe mine, situated within the town boundary.

JACKSON. The strike will result in a reduction of gold output from Amador county, even compared with 1914, if it lasts much longer. In 1915, 22 mines produced gold worth \$3,903,969 from 819,550 tons of ore, an average of \$4.76 per ton. This was a gain of 188,705 tons and \$812,123 compared with 1914.

KENNETT. The three-mile aerial tram from the Stowell mine to the terminal of the Balaklava mine has been completed by the Mammoth Copper Co. Ore can now be sent from the Stowell to Coram over the tram, then to the smelter at Kennett by rail.

NEVADA CITY. When the Alaska mine opens next spring W. S. Schuyler proposes to drive an adit one mile long, starting on Oregon creek. This work will be cheaper than draining and opening the mine by a shaft.

OAKLEY. The American Girl mine, controlled by wealthy Pasadena people, including Dr. R. Schiffmann, is said to contain large low-grade orebodies, and is extensively developed to a depth of 700 ft. A modern 150-ton mill, after considerable re-modeling, was successfully operating when the mine was flooded by a cloud-burst which ripped the timbers out of the shaft and filled most of the workings with stope-fillings. Shares of the company had already been issued at par, and no less than nine assessments of 10% were then levied in order to again put the mine in shape and continue development. An expensive arrangement was also constructed to prevent a similar occurrence damaging the property. The shareholders do not number more than twenty, and this method of practically doubling the capitalization was met without requiring outside aid. Owing, however, to the mine developing into a large low-grade property requiring extensive further development, no doubt it was considered advisable to sell to Eastern capital or to undertake some drastic scheme of re-financing.

(Special Correspondence.)—The option of W. J. Loring and associates on the Hardenberg mine, situated near the Mokelumne river, 3½ miles south of Jackson, dated from September 1, but work has been delayed on account of the strike in Amador county. The property consists of 41 acres, and covers the lode for a distance of 2129 ft. along its strike. The new vertical shaft is on a "caddle" between two hills, about 1600 ft. above sea-level. The mill is on the hill-side below the shaft collar. It is said that this was one of the first quartz-gold mines to be operated in California. The old mill had stamps with wood steps. In 1893 a shaft was sunk 600 ft. About that year C. D. Dine and Alvinza Hayward took an option on the mine. From April 1894 to 1895 there was treated 2100 tons of 34½% ore. F. G. Martin, manager of the Utica Mining Co. of Angels was then in charge, and attributes the suspension of work to the disinclination of Hayward to spend

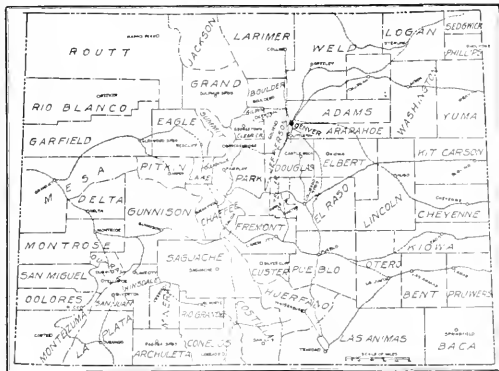
more money on the property, being then heavily involved elsewhere. From 1895 to April 1911 the mine was idle, when the Hardenberg Mining Co. took it over. The new vertical shaft was sunk and gold was extracted until 1914. The vein occurs at or near a contact between the amphibolite schist on the east, and the Mariposa slates on the west. The shoot is from 2 to 12 ft. wide of white quartz, a little quartz and slate being on the foot-wall. Between February 1, 1913, and 1914 records show that 26,478 tons yielded \$57,029 by amalgamation and \$8941 by concentration. The Hardenberg company made no profit, but opened a shoot that assayed \$6.10 per ton. Physical conditions were not suitable for economic mining and the ore was not mined clean. Machinery installed is worth over \$15,000, and permanent improvements cost over \$30,000. Without the risk of losing much money the property is worth re-opening. James F. Parks, superintendent of the Plymouth Consolidated, is in charge. Thus another chapter is being added to the re-opening of old mines along the Mother Lode.

Plymouth, October 6.

PORTOLA. The Walker company is to erect a hydro-electric plant, utilizing water from tributaries of the Feather river. The head will be 514 ft., developing 1165 hp. The company is employing 125 men at its mine and mill.

COLORADO

According to the State mining commissioner, Fred Carroll, 350 new mining companies have been incorporated in this



MAP OF COLORADO.

State since the beginning of the year. The 1916 mineral output will exceed that of 1915 by 25%.

BRECKENRIDGE. On October 1 the Wellington Mines Co paid No. 12 dividend, equal to \$200,000, making \$600,000 for the year. Both mills are working full time, producing 2500 tons of concentrate in September.

(Special Correspondence.)—The new flotation plant of the Vindicator Consolidated is expected to be in full operation at an early date. The daily capacity will be 500 tons.

During September the Roosevelt drainage-tunnel was advanced 456 ft. The flow from the portal is 9650 gal. per minute. The heading is now in the Comstock lode, about 1751 ft. north-east from the Elkton main shaft.

At a recent meeting of the directors of the United Gold Mines Co. the following officers were elected: president, A. E. Carlton; vice-president, H. McGarry; secretary-treasurer, Ray Wilson, and superintendent, S. J. Russell.

It is reported that exploration in the Cresson mine has opened the downward extension of the rich vug that yielded over \$1,000,000 about two years ago. A special meeting of the

shareholders of the Cresson Consolidated has been called for November 7.

Cripple Creek, October 9.

SALIDA. The Standard Chemical Co. is to put on 250 miners to resume extraction of carnotite or radium-bearing ore in Paradox valley.

IDAHO

BURKE. The Sherman Development Co. has enlarged and straightened its 1800-ft. adit to allow of a horse being employed to haul cars. The adit is now being extended.

ENAVILLE. The 150-ton mill of the Empire Copper Mining Co. on the little north fork of the Coeur d'Alene river is to be doubled in capacity, according to A. J. Devlia, vice-president. Power is supplied by the Washington Water Power Co. A 22-drill compressor was recently installed, also a filter-press to reduce moisture in concentrate to 10%. The concentrate goes to Trail, B. C., at a cost of \$8.50 per ton for freight and treatment. Sixty men are employed. Three adits have opened long ore-shoots, the copper-content being from 3 to 5%.

WALLACE. Negotiations are pending for the purchase of the holdings of the Portland Mining Co., consisting of the Sitting Bull, Silver Tip, Mule Deer, and Red Dragon claims in the Beaver Creek district, by the Sunshine Mining Co., which also is endeavoring to secure the Parrot claim. The Sunshine company is controlled by the Day brothers.

ILLINOIS

ROSLICLARE. Labor troubles at the Rosiclare Lead and Fluorspar Mining companies' properties are holding-up 85% of the fluorspar production of the United States. Some violence is reported, and the Governor has investigated.

MICHIGAN

HOUGHTON. Copper production for this year will be fully 280,000,000 lb. If labor were sufficient the total would be 20,000,000 lb. more.

Savings deposits in this region are the largest in its history and six times those of three years ago, totaling \$19,000,000.

Early next month the Calumet & Hecla will use flotation in a small way as part of its treatment.

MISSOURI

JOPLIN. Zinc ore prices were steady but featureless during the past week, the range being from \$45 to \$65 per ton for 60% metal-content. There was a shortage of electric power for all work. The Oklahoma districts continue to turn-in large quantities of concentrates. The region output was 6984 tons of blende, 841 tons of calamine, and 762 tons of lead, averaging \$56, \$42, and \$74 per ton, respectively. The total value was \$478,641.

A 250-ton mill is to be built for the Eaglewood Mining Co. near Belville.

The new 400-ton mill of the A. R. G. Mining Co. north of Duenweg started work last week.

NEVADA

In Bulletin 640-F of the U. S. Geological Survey, Henry G. Ferguson describes the Golden Arrow, Clifford, and Ellendale districts of Nye county. The Clifford district is 35 miles east of Tonopah, on the road to Ely. Neither area has produced much ore; Ellendale is abandoned. The formations belong to the class of shallow-vein deposits in which the mineralization followed closely the extrusion of lavas. The gold-silver ores are in close association with andesite.

MINA. Thirty miles from this place the Olympia Mines Co. is operating the Royal George gold mine. Reserves of \$30 ore are estimated at \$1,500,000. A 50-ton mill is being erected.

TONOPAH. Last week 10 mines produced a total of 8602

tons of ore valued at \$170,776. The Belmont contributed 2445 tons; Tonojap Mining, 900; Extension, 2380; Jim Butler, 100; West End, 695; Rescue, 219; Midway, 77; Halifax, 158; North Star, 66; Montana, 36; and miscellaneous, 26 tons. Silver shipments were \$132,370 by the Belmont, \$59,619 by the West End, and \$79,300 by the Extension. The West End pays 5c. per share on October 21; this equals \$89,516.

NEW MEXICO

(Special Correspondence.)—At the Pacific mine a 31-ft. vein has been cut on the 600-ft. level. The head-frame and loading-bins for the wire-rope tramway are about completed.

The Socorro M. & M. Co. has eliminated concentrating tables in its mill and will turn all of its product into bullion. The change has effected an increased recovery. The plant treats 230 tons of ore daily.

The new 3-compartment shaft of Mogollon Mines Co. has reached a depth of 950 ft. Ore-pockets and sump are being cut, and development will be started from both the 800 and 900-ft. levels. This mine has been producing steadily for a number of years, and from a block of ground 2000 ft. long by 700 ft. high has yielded upwards of \$6,000,000 in gold and silver. This new development will open virgin ground, and undoubtedly will add large reserves to the property.

The Oaks company has been packing ore to custom mill all the week from development on the Clifton and Eberle mines. Mogollon, October 10.

OREGON

The U. S. Geological Survey has issued C. G. Yale's 'Mineral Report' of 11 pages on the gold, silver, copper, and lead output of Oregon during 1915. A total of 95 mines, from which 155,791 tons of ore was extracted, was \$1,861,796 gold, 117,917 oz. silver, 451,172 lb. copper, and 62,957 lb. lead. The total value was \$2,003,509. There was a decrease of 10 producers, but all metals save silver increased, the value being \$327,356 more than in 1914.

SHUFER. Mining operations will be resumed at the Congar mine in the next 30 days, according to C. C. Robbins, secretary-treasurer of the United Gold Mining Co. of Spokane, which recently purchased the property from the former owners. The old mill is being re-modeled. A 21-mile pipeline is being laid to provide water for power and milling purposes. As soon as these betterments are completed production will begin. The former operators of the property did not make a success because the concentrating system employed was not suited to the peculiar character of the ore. Exhaustive tests of different systems have been made, and a satisfactory recovery is possible by finer grinding before cyanidation. The former management used cyanide, but did not reduce the ore sufficiently to get the desired results. The plant has a capacity of 125 tons, provided by two 5 by 8-ft. tube-mills and five 20-ft. cyanide tanks. About \$150,000 had been expended on development and improvement up to the time the new company bought the property. About 5000 ft. of work had been done on the vein, blocking-out 100,000 tons of ore worth over \$1,000,000. The engineer who supplied these figures took 176 samples, and in assaying and calculating the total value he eliminated all values above \$20 per ton. It has been estimated that 31,000 tons above the first and second levels has an average of \$11 per ton. The calculated cost of stoping and milling is \$3. The shoot is continuous for 1100 ft., and has a lack of 200 ft. at its interior extremity. Another \$1,000,000 will be added to the resources by driving an adit 100 ft. below the upper block of the ore continues. This adit is now in 500 feet.

TEXAS

(Special Correspondence.)—It is reported here that Pachua in Mexico has been taken by the reactionists. Communication with Mexico City was cut. The mines will have to close

shortly on account of shortage of cyanide. At El Oro all the mills were at work save that of the El Oro company. No mines are being operated in the Zacatecas or Guanajuato districts. The general opinion in Mexico City is that the Constitutional government will be finally overcome by the many revolutionary forces forming in all parts of the country. Various pestilences are killing three or four times as many people as bullets.

Laredo, October 1.

UTAH

ALTA. It is reported that the mining companies of the Big Cottonwood district are considering the improvement of roads between their mines and Park City for handling of ore to the latter instead of down the canyon. Early in November the new Alta-Cottonwood railway is expected to be finished.

Three shifts are driving the Alta Tunnel & Transportation Co.'s adit, which is now in over 2000 ft., two shifts drilling and the third cleaning out. A suction-fan at the portal improves ventilation considerably.

BINGHAM. The Utah Consolidated company is paying quarterly dividends of 75c. per share, and will close the current year with \$3,000,000 cash and quick assets. In 1910 it was reported that the mine was nearly worked out, but in the five years following the output from 1,080,264 tons of ore was 29,799,987 lb. copper, 63,620,280 lb. lead, 1,424,512 oz. silver, and 79,859 oz. gold. Dividends totaled \$8.50 per share.

GOLD HILL. The Western Pacific is to construct a 41-mile railway into Deep Creek, from Wendover to this place in Tooele county, where the Western Utah Copper Co. is working.

PARK CITY. Thirteen mines in this district shipped a total of 6443 tons of ore and concentrate during September.

SALT LAKE CITY. The Utah Copper Co. expects to have its leaching plant at work within two months. Good progress is being made at the acid plant and improvements in the mills.

WASHINGTON

HUNTERS. The Chloride Hill Mining Co., capitalized at 1,000,000 \$1 shares, has been organized by Spokane men to take over and develop the old Santiago silver mine, on the Columbia river, two miles from this place in Stevens county. E. G. Ross is president and R. B. McClary secretary-treasurer. The property is one of the oldest in the county, and was fairly well developed by former owners. Because of lack of transportation facilities, the high cost of freight and treatment charges, and the low price of silver, the property was abandoned several years ago, except that enough work was done each year to cover assessment requirements. Dumps contain 10,000 tons of ore. The lode contains a high-grade shoot.

NORTHPORT. As deep development of the Great Western and Last Chance mines near here have been a disappointment, the Norman Mines Co. is to suspend work. About \$25,000 of zinc carbonate ore was shipped to Eastern smelters, but the shoot showed no persistence with depth.

RURIC. During the quarter ended September 30 the Knob Hill Mining Co. received \$17,708 from 12 cars of ore sent to Trail, B. C. It cost \$10,563 to mine and treat this ore. There was \$3194 paid on the Alpine claim, which has good promise. The cash balance is \$6713.

WYOMING

Cody. A cave of high quality sulphur has been broken into at the Midwest Sulphur Co.'s mine. The walls are lined with 12 to 18 in. of a purer of 99% purity. Present profits are \$2000 monthly. An initial dividend of 1% was paid on October 1. At present prices the ore in the quarry is worth \$750,000, and that in new ground \$1,000,000. The net value is \$151,000. The production cost is \$13 per ton of sulphur.

CANADA

BRITISH COLUMBIA

GRAND FORKS. During the year ended June 30, 1916, the Granby Consolidated Mining, Smelting & Power Co. produced 42,198,083 lb. copper, 44,848 oz. gold, and 487,845 oz. silver, against 26,638,912 lb., 31,388 oz. and 377,881 oz., respectively. The tonnage reduced last year was 1,897,251 tons, against 1,098,020 tons in the previous year. The Anyox plant reduced 822,919 tons. The matte is sent to Grand Forks for conversion into blister copper. Reserves total 9,947,000 tons of 2 to 2½%, 3,718,000 tons of 1 to 1½%, and 9,491,000 tons of less than 1% copper-content, a total of 23,156,000 tons. Development at Phoenix did not replace the ore mined by 721,409 tons; at Anyox there was an increase of 182,833 tons over that extracted. Costs were reduced from 10.09 to 8.54c. per lb. Sales of metals amounted to \$9,299,337, more than double that in 1914-15. The profit was \$3,819,295, nearly four times larger. Dividends were \$899,911. The surplus is \$2,919,384, compared with \$929,168.

SILVERTON. From settlements of silver-lead and zinc concentrates in September the Standard company made a profit of \$53,399. The revenue was \$88,863. The balance on August 31 was \$287,662.

YMLR. For the sum of \$75,000 the Canadian Pacific claims of Edward Peters and others are to be sold to John Arbuthnot of Victoria and New York partners. Four veins contain good value in gold and silver.

ONTARIO

One of the largest known deposits of barite is that of the Premier Langmuir Mining Co. of Toronto, J. A. McIntosh president. The mine is on Night Hawk lake, reached by water from Connaught station. Fifty thousand tons is the estimated quantity. Native silver is found with the barite.

PORCUPINE. During September the Dome mill treated 38,300 tons of \$4.68 ore. Costs were 76c. for mining, 60c. for development, 10c. for crushing, 82c. for treatment, and 31c. for general expenses.

KOREA

During August the Oriental Consolidated treated 25,210 tons of ore for bullion worth \$128,751. Generally everything is working well.

The Seoul Mining Co., operating the Suan concession in Whang Hai province, reports a total recovery of \$128,065 in September.

At the monthly meeting of the San Francisco Section of the AMERICAN INSTITUTE OF MINING ENGINEERS, held on October 10, the following resolution was passed unanimously:

Resolved: That it is the sense of the San Francisco Section of the American Institute of Mining Engineers that Paper No. 150, by Wm. H. Shockley, entitled: 'The Economic and Social Influence of Mining with Special Reference to the United States,' as finally revised by him, gives evidence of wide reading and careful study, is manifestly temperate in tone, and his findings are chiefly based upon authoritative publications which are cited, and should have been accepted as a contribution to the Transactions of the International Engineering Congress, with the full consent and approval of the American Institute of Mining Engineers as part of that Congress, and that the action of the directors of the American Institute of Mining Engineers in censoring the publication of that paper is unwarrantable, in that the part of Mr. Shockley's paper apparently offensive to the Anthracite Section of our Institute is but a citation from official documents, authorized by the State of Pennsylvania and the Government of the United States, the conclusion therefrom being his own, and frankly so stated.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

F. F. BOSTWICK is at New York.

JOHN W. FINCH has gone to China.

O. B. PERRY is here on his return from the Yukon.

JOHN SEWARD has been examining mines in Ontario.

H. D. GRIFFITHS has returned to London from Burma.

S. M. SOUPCOFF has returned to Pittsburg from Alaska.

JOHN F. COWAN, of Salt Lake City, is at Tucson, Arizona.

DEANE P. MITCHELL is expected here shortly, from London.

R. W. ATWATER has been on a visit to the Coeur d'Alene, Idaho.

ROBERT B. BRINSMADE has returned from St. Louis to Phebia, Mexico.

J. B. TYRRELL has been inspecting the Rice Lake goldfield, in Manitoba.

W. C. SEAGRAVES has resigned as manager of the Kennecott mine, Alaska.

H. H. KNOX has gone from New York to London, on his way to Siberia.

J. VOLNEY LEWIS has returned from Alaska to New Brunswick, New Jersey.

H. FOSTER BAIN sails by the *Empress of Japan* from Vancouver on November 2.

A. E. DRUCKER has moved his office from London to 1502 Pacific street, Brooklyn, N. Y.

E. COPPEE THURSTON has left London and will reside in California, probably at Berkeley.

V. A. HART has been appointed manager of the Walker copper mine at Portola, California.

J. J. McDONALD is making a two months' professional trip to Chicago, New York, and the East.

K. C. LI has been appointed president of the Hunan lead smelting works by the Hunan Mining Board.

B. L. THANE, manager for the Alaska Gold Mines Co., has been in San Francisco, on his way to New York.

WILLARD S. MORSE is at Chuquicamata, Chile, where his address is care Chile Exploration Co., via Antofagasta.

C. O. LINDBERG of Los Angeles has been examining zinc mines in the Kootenay district of British Columbia.

EDWIN E. CHASE and son have started for the Granby district, British Columbia, where they will be until November 1.

D'ARCY WEATHERIE is at Toronto, having traveled through Trans-Caucasia, Persia, the Altai, and Korea. He will proceed to London early in November.

FREDERICK BRADSHAW, manager for the Tonopah Belmont Development Co., has been to the Surf Inlet mine, on an island off the coast of British Columbia.

W. A. CARLYLE is a director for the British-America Nickel Corporation. He went to Butte recently to engage E. P. MATHEWSON as general manager.

J. H. GARRY and R. J. KING, of the Tonopah Belmont Development Co., were recently at Prince Rupert, British Columbia, on their way to Surf Inlet on Princess Royal island.

EDWIN HIGGINS has resigned from the U. S. Bureau of Mines and California Industrial Accident Commission to open an office in San Francisco as safety and efficiency engineer.

V. E. LEDNICKY has been appointed chief geologist of the Philippine Bureau of Science. Mr. Lednický is a graduate of the University of Kansas and during the past two years has been connected with the Bureau of Science as mining engineer.

The Western Branch of the CANADIAN MINING INSTITUTE has been definitely arranged to meet at Trail, B. C., on Thursday, October 26. E. Jacobs is secretary at Victoria.

THE METAL MARKET

METAL PRICES

San Francisco, October 17

Antimony, cents per pound.....	11.50
Electrolytic copper, cents per pound.....	29.25
Pig lead, cents per pound.....	7.25—8.50
Platinum: soft and hard metal, per ounce.....	\$90—94
Quicksilver, per flask of 75 lb.....	78
Spelter, cents per pound.....	12
Tin, cents per pound.....	42
Zinc-dust, cents per pound.....	20

Quicksilver bulletin of the U. S. Geological Survey is to hand. In 19 pages the 1915 history of the metal is discussed.

ORE PRICES

San Francisco, October 17.

Antimony: 50% metal, per unit.....	\$1.00
Chromite: 40% and over, f.o.b. cars California, per ton.....	13.99—16.00
Magnetite: crude, per ton.....	8.00
Manganese: 50% (under 35% metal not desired).....	11.00 and up
Tungsten: 60% WO ₃ , per unit.....	17.00

New York, October 11.

The demand is light and only small quantities have moved, those bringing \$1.10 to \$1.25 per unit, according to quality.

Molybdenite: For this mineral there is a good export demand, but it is difficult to obtain. Small quantities have been taken at \$1.50 to \$1.75 per lb. for MoS₂ contained.

Tungsten. Several hundred tons have changed hands at \$17 per unit. Buyers are showing more confidence, and it is believed that the bottom of the market has been touched. One contract has been made to cover all of 1917, the price being \$17, other contracts on the same basis are being negotiated.

EASTERN METAL MARKET

(By wire from New York.)

October 17. Copper is dull though steady, quotations are for prompt metal, lead is dull and unchanged, spelter is quiet and easy.

SILVER

Below are given the average New York quotations, in cents per ounce, of the silver.

Date.	Average week ending
Oct. 11.....	67.87
" 12 Holiday.....	68.10
" 13.....	67.87
" 14.....	68.00
" 15 Sunday.....	68.95
" 16.....	69.12
" 17.....	68.75
Monthly averages	
Jan. 1914.....	48.85
Feb. 1915.....	56.76
Mar. 1916.....	71.09
Apr. 1917.....	47.52
May 1918.....	47.11
June 1919.....	68.07
July 1920.....	68.51
Aug. 1921.....	68.51
Sept. 1922.....	68.51
Oct. 1923.....	68.51
Nov. 1924.....	68.51
Dec. 1925.....	68.51

The past week's movements do not indicate we know, the tone is much better than would appear from the figures, which are small and of short duration. China is buying less from and is turning to the metal, while India is buying more as well.

London supply to London remains in the 100,000 to 150,000 mark, the coming holiday season has not yet started. The London Mint will buy silver from the banks always as much as it can from 70 days before.

London produced at \$126.00 was sent from San Francisco to the United States on October 16.

COPPER

Date.	Average week ending
Oct. 11.....	8.00
" 12.....	8.00
" 13.....	8.00
" 14.....	8.00
" 15 Sunday.....	8.00
" 16.....	8.00
" 17.....	8.00
Monthly averages	
Jan. 1914.....	8.00
Feb. 1915.....	8.00
Mar. 1916.....	8.00
Apr. 1917.....	8.00
May 1918.....	8.00
June 1919.....	8.00
July 1920.....	8.00
Aug. 1921.....	8.00
Sept. 1922.....	8.00
Oct. 1923.....	8.00
Nov. 1924.....	8.00
Dec. 1925.....	8.00

Monthly averages

Date.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Jan.	14.21	13.60	24.30	July	12.36	19.09	25.66						
Feb.	14.46	14.78	26.82	Aug.	12.31	17.27	27.03						
Mar.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28						
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	...						
May	13.97	18.71	29.02	Nov.	11.75	18.88	...						
June	13.60	19.75	27.47	Dec.	12.75	20.67	...						

Bradon produced 2,970,000 lb. in September; Arizona Copper, 1,180,000; Chile Copper, 4,038,000; Greene-Canaan, 4,900,000.

United Verde Extension is producing 3,000,000 lb. per month from 8000 to 8500 tons of ore.

Shannon is paying two dividends of 25c. each on November 15. United Verde on September 20 paid 75c. per share; this is the fifteenth consecutive dividend of similar amount.

United States Smelting, Refining & Mining Co. pays, on October 14, \$1 per share on common and \$7 1/2c. on preferred stocks.

LEAD

Date.	Average week ending
Oct. 11.....	7.00
" 12.....	7.00
" 13.....	7.00
" 14.....	7.00
" 15 Sunday.....	7.00
" 16.....	7.00
" 17.....	7.00
Monthly averages	
Jan. 1914.....	4.11
Feb. 1915.....	2.73
Mar. 1916.....	5.95
Apr. 1917.....	4.02
May 1918.....	3.83
June 1919.....	4.24
July 1920.....	4.04
Aug. 1921.....	4.21
Sept. 1922.....	4.21
Oct. 1923.....	4.21
Nov. 1924.....	4.21
Dec. 1925.....	4.21

Date.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Jan.	4.11	2.73	5.95	July	3.80	5.59	6.40						
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28						
Mar.	5.94	4.04	4.26	Sept.	3.82	4.62	6.86						
Apr.	3.86	4.21	7.00	Oct.	3.69	4.62	...						
May	3.90	4.24	7.28	Nov.	3.68	5.15	...						
June	3.90	5.15	6.88	Dec.	3.80	5.34	...						

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Oct. 11.....	9.75
" 12.....	9.87
" 13.....	9.87
" 14.....	9.87
" 15 Sunday.....	9.87
" 16.....	9.75
" 17.....	9.75
Monthly averages	
Jan. 1914.....	5.11
Feb. 1915.....	6.20
Mar. 1916.....	9.05
Apr. 1917.....	5.12
May 1918.....	8.40
June 1919.....	18.40
July 1920.....	9.78
Aug. 1921.....	16.61
Sept. 1922.....	16.61
Oct. 1923.....	16.61
Nov. 1924.....	16.61
Dec. 1925.....	16.61

Date.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Jan.	5.11	6.20	18.21	July	4.75	20.50	9.90						
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03						
Mar.	5.12	8.40	18.40	Sept.	5.16	14.11	9.18						
Apr.	8.40	18.40	18.62	Oct.	4.75	14.05	...						
May	4.91	17.93	16.61	Nov.	5.01	17.20	...						
June	4.84	22.26	12.85	Dec.	5.40	16.75	...						

American Zinc, Lead & Smelting pays \$1.50 per share to preferred holders on November 1. Absorption of the Granby company is about completed.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
Sept. 19.....	75.00
" 26.....	75.00
Monthly averages	
Jan. 1914.....	71.30
Feb. 1915.....	71.30
Mar. 1916.....	71.30
Apr. 1917.....	71.30
May 1918.....	71.30
June 1919.....	71.30
July 1920.....	71.30
Aug. 1921.....	71.30
Sept. 1922.....	71.30
Oct. 1923.....	71.30
Nov. 1924.....	71.30
Dec. 1925.....	71.30

Date.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Jan.	71.30	71.30	71.30	July	71.30	71.30	71.30						
Feb.	71.30	71.30	71.30	Aug.	71.30	71.30	71.30						
Mar.	71.30	71.30	71.30	Sept.	71.30	71.30	71.30						
Apr.	71.30	71.30	71.30	Oct.	71.30	71.30	71.30						
May	71.30	71.30	71.30	Nov.	71.30	71.30	71.30						
June	71.30	71.30	71.30	Dec.	71.30	71.30	71.30						

TIN

Date.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Jan.	27.85	34.40	41.76	July	21.60	37.38	38.27						
Feb.	27.85	37.23	42.60	Aug.	20.20	34.37	38.88						
Mar.	27.85	48.76	50.50	Sept.	23.10	33.12	36.66						
Apr.	27.85	51.15	51.19	Oct.	23.10	33.12	36.66						
May	27.85	51.15	51.19	Nov.	23.10	33.12	36.66						
June	27.85	51.15	51.19	Dec.	23.10	33.12	36.66						

Eastern Metal Market

New York, October 11.

Copper is quiet, but strong.

Zinc was feverishly active on the 5th, but the excitement lasted only one day, practically. The spot price went up to 10c. St. Louis, but has since declined $\frac{1}{8}$ c.

Lead continues steady in a quiet market.

Tin is higher because of the German submarine activity. It is now quoted at over 42c.

Antimony has a better tone.

Aluminum is stronger because of the scarcity of virgin metal.

In iron and steel but little change is to be quoted. One feature that stands out is the generally accepted belief that prosperity is here to stay a long time, a belief that some interests are willing to substantiate by contracting for material into 1918. Railroads, for instance, have closed for 100,000 tons of rails for first-quarter delivery in 1918. The railroads continue to buy cars, evidently having determined that lower prices are not to be expected for months to come. The heavy buying of steel-making iron is subsiding, consumers having covered their needs, but foundry iron is gaining in strength. For months it has been a laggard. The activity of a German submarine off the New England coast has sent up marine-insurance rates, also freight-rates, and some shipments have been held-up. Munition shipments, however, are going forward without interruption. A shortage of cars is hampering the movement of Lake Superior iron ore from Lake Erie docks; also interfering with shipments of coke, the Pennsylvania Railroad refusing to ship coke in box-cars. The base price of tin-plate has been fixed at \$6 per box for the first half of next year.

COPPER

The market is quieter, but its strength is not impaired, and hardly likely to be in view of the well-booked condition of the producers. As a matter of fact, they are independent, as they can afford to be. Near-by metal does not appear to be of great interest to consumers, but there is a fair amount of inquiry for next year, particularly the first quarter. As to the quotation for this position, there is some difference of opinion, but it is certain that it can be obtained at from 27 to 27.50c. Late last week, a manufacturer was offered first-quarter copper at 27c., but at the moment could not make up his mind to buy. The following day he offered to pay the price mentioned, but was told that 27.25c. was the price. Second-quarter Lake has sold at 27.12 $\frac{1}{2}$ c. Spot electrolytic is quoted at 29c., November at 28.50c., and December at 28c. Lake is nominally the same. A dealer parted with a round lot of spot electrolytic at 28.50c. Activities of the German submarine on this side of the Atlantic has had no pronounced effect on the market. Incidentally, in the past few weeks about 4,600,000 lb. of copper has been lost through the sinking of vessels, out of which some of the financial papers have tried to make capital. Exports to the 10th totaled 7125 tons. The London quotation yesterday for spot electrolytic was £142, compared with £140 a week previous. Exports of brass in bars, plates, etc., in the first seven months of this year totaled 51,372 tons, against 18,089 tons in the same period of 1915. The brass mills are further than ever behind in deliveries. Where they can and choose to quote on deliveries inside of two or three months they expect premiums.

ZINC

Thursday of last week was a wild day in the spelter market, and prices went up with a rush to 10c., St. Louis, even to 10.12 $\frac{1}{2}$ c., while in New York, from 10.17 to 10.37 $\frac{1}{2}$ c. was asked. Buyers paid 10c., St. Louis, for prompt and October, and 9.75 to 10c. for November and December. Heavy pur-

chases were made by those who ordinarily are sellers, for what reason is not apparent, until they were short of metal where-with to make deliveries. On Friday there was less doing, and by Monday of this week, sellers were looking for business and the quotations had declined several points. Yesterday prime Western was quoted at 9.75c., New York, and 9.50c., St. Louis, November at 9.37 $\frac{1}{2}$ c. St. Louis, and December, at 9.25c. Sellers say that the market has been quieted by the activity of the German submarine, but just why this is so is not explained. If brass or zinc is sent to the bottom of the sea it means that just so much more will have to be supplied. The sinking of six ships by the German submarine has not checked the exportation of munitions from this port. The demand for brass-mill special is not heavy, nor was it so during the flurry referred to. The mills are covered, and in addition, are using large quantities of high-grade scrap. Exports from the 1st to the 10th totaled 3032 tons. The spot price at London yesterday was £56, against £52 a week previous. There has been no change in the price of sheet zinc, and for carload lots 15c., f.o.b. mill is quoted, 8% off for cash.

LEAD

The A. S. & R. Co. continues to quote 7c., New York, and 6.92 $\frac{1}{2}$ c., St. Louis, while the independents ask 7 to 7.12 $\frac{1}{2}$ c., New York, and 6.85 to 6.90c., St. Louis, but it is safe to assert that but little business is being done above 7.05c., and most of it is at 7c., New York, unless spot shipment is wanted, when a premium is asked. The market has been quiet, but steady, throughout the week, and features of interest are lacking. Exports in 10 days totaled 1882 tons. The London quotation yesterday was £30 15s., against £31 15s. a week previous.

TIN

The market was stirred to great activity on Monday, the 9th, by the news that a German submarine had sunk ships off the New England coast. Great uncertainty prevailed for a time as to the price of spot, but at last it was fairly well established at 42.75c., although there were not many sellers at that figure. Consumers showed great interest in futures, and probably 500 tons was taken, 40.75 to 41c., being paid for November and December deliveries. Incidentally, Banca was active and sold around 41.60c. Late last week a good business was quietly done, and several hundred tons of Straits changed hands at around 39.75c. At that time Banca was sold for delivery from the Far East at 38.75c. The latter buying was regarded as interesting, as indicating a resumption of shipments from the East. For a time they had been halted. In this market there has been a surfeit of spot Banca, and it was thought that some of the holders would lose money. There is now afloat, en route to this country, 2245 tons of tin, while the arrivals of the month total 1015 tons.

ANTIMONY

A good business has been done in metal in bond, the prices ranging from 9.50 to 9.75c., but re-sellers offer the metal at 11.50c., duty paid.

ALUMINUM

Virgin metal is scarce, and prices have advanced to 63 and 65c. Re-melted material, 98 to 99% pure, guaranteed, is strong at 61 to 62c., while No. 12 re-melt alloy is offering at 47c. Sheet aluminum is held at 80 to 85c. for prompt deliveries. The producers' contract price for 1917 is unchanged at 35c. for ingots, but they are understood to be out of the market. In the first 8 months of 1916 exports of aluminum and manufactures thereof totaled \$4,867,743, against \$2,994,072 for the entire year of 1915. The British Government has been a heavy buyer.

Recent Publications

U. S. Bureau of Mines, Washington, D. C., 1916:
SAFE PRACTICE AT BLAST-FURNACES. A manual for foreman and men. By F. H. Willeox. Technical Paper 136. P. 73. Ill., index.

UNDERGROUND WASIES IN OIL AND GAS-FIELDS AND METHODS OF PREVENTION. By William F. McMurray and James O. Lewis. Technical Paper 139, petroleum technology 39. P. 27. Illustrated.

ORE-SAMPLING CONDITIONS ON THE WEST. By T. W. Woodbridge. Technical Paper 86. P. 96. Ill., index.

This is a useful work, and an abstract is to be made for the Press.

HEALTH CONSERVATION AT STEEL MILLS. By J. A. Watkins. Technical Paper 192. P. 34.

Both employers and employees are advised to secure this paper that speaks straight out on safety-first and health.

RESCUE AND RECOVERY OPERATIONS IN MINES AFTER FIRES AND EXPLOSIONS. By James W. Paul and H. M. Wolfin. Page 109. Index.

This pamphlet is the result of serious studies covering a period of considerable time on what the Bureau believes to be the best method in rescue and recovery operations in both coal and metal mines after fires and explosions. It outlines a method of procedure for the operators and miners to follow in such emergencies, and explains just what part the Bureau is expected to take in such work. We are of the opinion that this paper should be in the hands of operators and every mine superintendent in the country.

A METHOD FOR MEASURING THE VISCOSITY OF BLAST-FURNACE SLAG AT HIGH TEMPERATURES. By A. L. Feild. Technical Paper 157. P. 27. Illustrated.

The Bureau of Mines has been conducting for the past year an investigation of the physical and chemical properties of blast-furnace slags at high temperatures, the work being a part of the research program of the metallurgical division. The present publication is the first of a series of reports on commercially important slag problems. Besides being of timely interest to metallurgist and blast-furnace men, on account of the increasing demand on their part for an investigation of the viscosity and desulfurizing properties of slags, this publication represents pioneer work in the field of high-temperature physico-chemical measurements. In attacking the problem Mr. Feild developed a high-temperature torsion viscometer which can be operated at temperatures as high as 1600° C., and which yields results expressed in terms of specific viscosity.

U. S. Geological Survey, Washington, D. C., 1906.
THE GOLDEN ARROW, CALIFORNIA, AND ELLENVILLE DISTRICTS, NYE COUNTY, NEVADA. By H. G. Ferguson. Bulletin 619. P. 11. Illustrated.

NOTES ON SOME MINING DISTRICTS IN EASTERN NEVADA. By James M. Hill. Bulletin 618. P. 211. Ill., map, index.

Both of these publications have been abstracted for the Mining Summary of the Press.

EXPERIMENT FROM THE FLOTATION LABORATORY. By C. Y. Kato and others. P. 40. Illustrated. Bulletin. School of Engineering and Metallurgy, University of Missouri, Rolla, 1916.

This is a laboratory flotation machine, 60" in diameter, in which the flotation values of oils, effect of frothing and non-frothing oil, carbon and its oil, concentrate, oil, and oil supply flotation oils, and an attempt to float copper carbonate.

NOTES ON THE RECOVERY OF COPPER FROM THE ORES BY T. A. C.

ING AND PRECIPITATION, IN THE UNITED STATES, AND APPLIANCES USED IN CONNECTION THEREWITH. Metallurgical report No. 1. By J. D. Connor. P. 56. Illustrated. Department of Mines, Adelaide, South Australia, 1916.

Details and summary of plants visited during 1915. Although only two were at work, the author has collected a large amount of general data.

PLANE SURVEYING AND EXERCISES IN SURVEYING. Combined edition. By John C. Tracy. P. 1004. Illustrated. For sale by the MINING AND SCIENTIFIC PRESS. Price \$3.

RESOURCES OF SANTA CRUZ COUNTY. By Allen T. Bird. P. 27. Bulletin 29, county resource series No. 1. University of Arizona, Bureau of Mines, Tucson, 1916.

Industrial Notes

Information supplied by the manufacturers.

P. H. Reardon has severed his connection with the GENERAL MACHINERY & SUPPLY Co. of San Francisco, having disposed of his interest to his associates. Joseph A. Buckley succeeds him as president. A. L. Green is vice-president, and H. F. Jurs is manager.

Charles A. Baechtold has arranged with the LINGERWOOD MANUFACTURING Co. of New York to establish a regular branch office at the Hibernian building, Los Angeles. From this office he will take care of business from the southern half of California, Arizona, and Nevada.

A leaflet issued by the EMPIRE CONCENTRATOR Co. of Denver briefly describes its machine, which is in successful operation in the Idaho Springs district of Colorado. Advantages claimed are large capacity—35 to 50 tons per 24 hours on 30-mesh feed—clean separation, small floor-space, simplicity, and low cost, water, and power consumption.

A 12-page booklet of the LEE ELECTRIC RADIATOR Co. of Chicago describes and illustrates its radiator. It is claimed that this type of heater has been in successful use for several years in offices, homes, and automobiles. The cost of operation is low. Compared with hot water and steam systems the electric radiator has temperature values greater than the first and nearly equal to the second system.

Robert C. Clifford, for the past four years district sales manager for the United States Cast Iron Pipe & Foundry Co. in charge of its St. Louis and Kansas City offices, is now associated with the WALTER A. ZENICKER SUPPLY Co. in St. Louis, in charge of its rail department. Bulletin 207 of this concern, of 10 pages, covers its business in rails, locomotives, cars, machinery, steel piling, and tanks of all types.

A new company has been formed for the purpose of taking over and operating the Peter McFarlane & Sons Iron Works of Denver. The leading spirits in the new company are Henry Eggers, president, and E. McFarlane, secretary and treasurer. Mr. Eggers is well known to the mining fraternity by reason of his connection as department manager with the Mine and Smelter Supply Co. of Denver for many years. He has resigned his position with the latter company and will give all his time and attention to the affairs of the new company, to be known as the McFarlane Eggers Machinery Co. The business of the company will be the manufacture and sale of mining and millinery machinery, including the development of a number of specialties. The launching of this new enterprise under such favorable circumstances as the present prosperous condition of the metal mining industry, combined with the experience and knowledge of the executive heads of the company, in business, is becoming an influential factor in Middle West manufacturing affairs.

EDITORIAL

T. A. RICKARD, Editor

TUNGSTEN is in fair demand and the market is firm at \$17.50 to \$20 per unit. The Allies have been placing orders in New York. The outlook is good for those mine operators that did not set their expectation of prices too high.

ACCORDING to the front page of the year-book issued by the American Institute, that organization is in the control of 15 "ditectors." Assuming that this is a misprint for 'detectors,' we are better able to understand the Shockley episode.

MINING engineers wishing to render patriotic service by joining the National Engineer Reserve can obtain particulars of the qualifications for a commission by writing to the Chief of Engineers, War Department, Washington, D. C. A number of Californians have volunteered for this service.

COPPER production was at its maximum last May, when the total output of domestic refineries was 190 million pounds; just now it is at the rate of about 165 million pounds per month. Hot weather, labor troubles, and the inability to secure delivery of needed equipment caused production to decline to 150 million pounds per month during mid-summer.

BBETTER means than strikes ought to be found for distributing prosperity among the laboring men, as also a better method should be discovered for sharing the evil of bad times. Arbitration is the obvious corrective for so much clumsy friction, but that assumes the interplay of intelligence and goodwill. In the end it is the cheapest as it is the fairest method for adjusting differences.

DEMANDS for a 7-hour day are foreshadowed by Mr. John P. White, president of the United Mine Workers. Of course, the workers have a 'right' to ask for as much as they can get and a little more, for that is what most of us do, but the insistence on the 8-hour interval as a normal shift becomes cynical in face of the further demand by organized labor. Are capital and labor to be at war always; if so, why pretend to placate?

COPPER dividends are most satisfactory and shareholders have reason to feel happy. The recent contract for the sale of 448 million pounds of metal to Great Britain and her allies means a profit of \$70,000,000 to shareholders during the first half of 1917. But it is foolish to talk, as brokers' circulars are doing, of copper

mining as an 'investment' at a time when so many essential factors are uncertain. It is a reasonable and most attractive 'speculation,' but it is no game for widows and orphans.

ON another page we publish a useful article describing a method for correcting the measurements made with a steel tape in mines. This article is written by Mr. Walter S. Weeks, Associate Professor of Mining in the College of Mines, University of California. Surveyors will be glad to have the use of the chart prepared by Professor Weeks; it affords a method for correcting, in one operation, all of the errors incidental to the stretch, sag, temperature, and initial error in a tape of any length up to 200 feet, and at any angle with the horizontal.

IAN HAY suggests that War will have at least one humanizing effect. He refers to the comradeship in the trenches, whereby the officer type of man learns to respect the courage, devotion, and intelligence of the men temporarily under his command, while the men correspondingly learn to appreciate the fact that their social superior is no mere child of fortune but a brave leader, quite willing to sacrifice himself in behalf of the national cause and anxious at all times to consider the welfare of those in his charge. This may not describe all the officers or all the men, but the suggestion of a real social solidarity and a mutual good understanding is unquestionable. It will have both political and economic consequences pleasant to contemplate.

THE Arizona Bureau of Mines issues a circular on the sale of ore and quotes the *Mojave Daily Miner* in a protest against "the extortion practised by the smelter concerns." The further remark is made: "There is a question whether any newspapers or magazines in the entire United States are prepared to take a stand in this matter and show up the robbery to which the shippers are subjected." This is incorrect; there are many newspapers and magazines that will give space to a discussion of the subject if presented in good faith and accompanied by a reasonable statement of facts. This paper is prepared to publish such a statement, as the *Mojave Daily Miner* and the Arizona Bureau of Mines ought to know. No good comes from calling people names or making vague assertions. For instance, the circular asserts that on a 10% copper ore the shipper receives only \$17.40 from the Arizona smelters. We would like to see a copy of the settlement between the shipper and the smelter, with an explanation of the circum-

stances. The smelting business is not conducted by Sunday-school teachers, of course, and advantage is taken of the little fellow in the ore business as in other affairs of life, but wrongs are not redressed by unsupported charges. We invite the Bureau of Mines to make good.

STATISTICAL prosperity is a new term applied to existing conditions in the United States. The inference is made that our prosperity is largely fictitious owing to a one-sided foreign trade, the persistent influx of gold, and the increasing cost of living. Neither a nation nor an individual can continue to sell continuously without buying from or lending to its customers. Hence the ingenious suggestion, made in the *New York Tribune*, that this country should refuse to receive further importations of gold. This can be bracketed with the unauthorized suggestion, made recently in the *London Statist*, that Great Britain may have to suspend specie payments. Evidently the abnormality of conditions is stimulating radical notions and reckless remedies.

WE publish a report of the discussion on flotation at *Globe*, on the occasion of the recent meeting of the American Institute of Mining Engineers. The many to whom the subject is of interest will find it well worth while to read what Messrs. David Cole, Rudolf Gahl, Frederick Laist, E. P. Mathewson, L. D. Ricketts, and O. C. Rakston said on that occasion. Apparently mill-men are still slow to appreciate the full scope of flotation; they cling to gravity methods of concentration even for the finer stuff that is peculiarly amenable to flotation. The part to be played by the new process in the flow sheet of a modern mill is still a matter for debate. As our readers will see, the discussion closed with a number of questions. That was fitting. Frank replies to many basic queries are still lacking. To formulate questions that recognize the essential factors is the best way to move forward to the solution of any technical problem.

LABOR is profiting from the expansive metal market and the wages of miners throughout the West have been raised, but what of the technical man on the staff of the mining company? Is he sharing the prosperity of his employer? Yes, in some instances; in others he finds it to his advantage to leave the office or laboratory and go to work on day's pay in the mine or mill. At Miami the pay roll of 1000 men now calls for the distribution of \$416,000 monthly, so that the average pay is \$416 per month. Miners are getting from \$4.50 to \$5.10 per shift. And yet the cost of producing the copper has not risen, this satisfactory result being due to the larger tonnage mined and milled, together with the improvements made in the mining and metallurgical processes to which the ore is subjected. One of the remarkable features of recent work in Arizona is the increased capacity obtained in mills without making expensive changes or costly additions to the plant; thus

the Miami mill with its former rating of 2000 tons daily is now treating 5000 tons and shortly will be doing even more. For that the technical man is to be credited; the laborer either on or below the surface is working no harder for his increased pay; it is brain not muscle that enables wages to be increased without invading the profit of the mine-owner. At Miami the members of the staff receive a bonus of 20% on their salary. They have earned it. We hope other companies will take the hint.

Prospecting and Prospectors

The passing of the old-time prospector has been bemoaned by several contributors to our 'Discussion' department. Many engineers appear to regard the prospector as a romantic humbug, while at least as many look upon the mining engineer as a pedantic prig. In this issue Mr. L. I. Rowland calmly states that "the average engineer falls short of the standard" by which the prospector measures him, especially if he be a graduate from a mining college. This is a fair retort to the technical men that complain of the time they waste in looking at the holes in the ground that the prospector calls mines. The ideal prospector is as rare, and no rarer, than the ideal engineer. The prospector to whom Nature is an open book is as uncommon as the engineer to whom the earth's crust is transparent; yet it is manifest that while much has been done to train the engineer, nothing has been done to educate the prospector, unless we regard the issuance of official bulletins by the Government bureaus as an educational propaganda for the unlettered. Behind all the discussion lurks the fundamental guess, how to find a mineral deposit and how to make money out of it. No more pertinent problem can be attacked in our pages. Two years ago we had a symposium on the subject, a number of experienced engineers recorded their ideas, and the trend of opinion was duly summarized in these columns. However, the question is iterative and we are aware that since then we have added several thousand new readers to our clientele. Upon a number of points most of us will agree: (1) that the cream of the mineral deposits has been skimmed, (2) that the prospector has fewer chances of making a rich discovery at grass roots, (3) that there is plenty of money for exploratory work, even if the old-fashioned grubstaking is less common, (4) that Government patronage of the prospector would breed graft and idleness, rather than effective search for mineral, and (5) that much of the public domain is sequestered by means of idle locations, that is, by the legal holding of ground without any real prospecting being done. Other factors concerning which we may be less in accord are (1) that the untechnical prospector has had his day and that the search for ore must be done henceforth largely by younger men with a scientific training, (2) that it would be well to combine the unscientific instinct of the old type with the scientific knowledge of the new school, (3) that the mining law should be modified so as to afford better protection to the genuine discoverer, (4)

that the publication of accurate information concerning the occurrence and characteristics of mineral deposits is the proper function of the State and Government, (5) that the building of roads and trails is the most immediate service that the State or Government can do for the further expansion of the mineral industry, and (6) that depreciation of the prospector or sneering at the young explorer is no good to anybody.

The Wilmington Decision

In the two preceding issues of this paper we have given our readers the text of the opinion submitted by Judge Bradford in the suit of Minerals Separation, Limited, v. Miami Copper Company. This decision of the U. S. District Court of Delaware in the second big flotation case has been made known on the eve of the revision of the first, or Hyde, case, taken before the Supreme Court of the United States on a writ of *certiorari* from the U. S. Court of Appeals in San Francisco. While the issues involved are not exactly the same, the main point, namely, the validity of Minerals Separation's basic American patent, No. 835,120, is common to both litigations. It will be recalled that in the first trial of the Hyde case, before the U. S. District Court at Butte, Judge Bourquin rendered a decision upholding the validity of patent 835,120, more particularly as against the defendant's claim that it had been anticipated by Froment's British patent. "The decision appears to have been largely influenced," so said the Court of Appeals, "by the consideration that the appellee's patent had gone into extensive and successful use" in foreign countries; but at that time, despite the expenditure of \$60,187 by Minerals Separation in the United States, not a single plant using their process, had been installed in this country. The Court of Appeals, in reversing the lower court in Montana, found that "each step in their [M. S.] process was fully described in more than one of the patents of the prior art, with the single exception of the reduced quantity of oil which they use." This reduction was "a valuable contribution to the art," but it was only a logical effort at economy and could not "be made by itself, or in combination, the subject of a patent." The Court affirmed that Minerals Separation could not take from others "the right to use oil economically" and it refused to give the owners of patent 835,120 "a monopoly of that which others had discovered." So said the U. S. Circuit Court of Appeals in San Francisco. Now we have another District Court upholding the Minerals Separation patent in a second litigation at the very moment when the first litigation is to be reviewed by the Supreme Court of the United States. Obviously, it would have been well if both cases could have been taken under final advisement at the same time. As it is, an appeal from Judge Bradford's decision has been made already and will be heard before the Court of Appeals at Philadelphia, but no conclusion is likely to be reached before the Supreme Court finishes the Hyde case.

The Wilmington decision is that the diminution of oil

to less than 1% of the weight of the ore is patentable. The discovery claimed to have been made by A. H. Higgins, in March 1905, acting under the supposed direction of Messrs. Subman, Picard, and Ballot is recognized by the Court as a genuine consequence of experimental work on the Cattermole patent. Thus patent 835,120 is pronounced the legitimate offspring of patent 777,274; in other words, a process for floating sulphide minerals was evolved logically from a process devised to sink them. Before that time, 1905, the proportion of oil used in flotation processes had been much greater; it had decreased in six years from a ton, or even more, of oil per ton of ore in Elmore's first bulk-oil process to three pounds in the Elmore vacuum process. The Court ignores this rapid diminution in the quantity of oil and finds that below 1% (or 20 pounds per ton) a new metallurgical principle comes into play. Judge Bradford sustains claims 1 and 12 of patent 835,120, specifying the use of less than 1% of oil, but declares invalid claim 9, which calls for "a small quantity" of oil. In short, he plants his decision squarely upon the ground that there is a difference in result growing out of the use of less than 1% of oil as distinct from more than 1% of oil. The Judge does not state what this difference is; apparently he is unable to explain the difference; although both parties to the suit acknowledged that the presence of some oil or other modifying agent is necessary to cause the bubbles to persist long enough to serve as a carrier of mineral. Moreover, Judge Bradford disregards the evidence brought forward by the defendant to establish the identity of result when more than and less than 1% of oil is used. We refer, of course, to the famous bubble-holder experiments, the importance of which was enhanced by the fact that they were introduced first by the plaintiff, not by means of experiments conducted before the eyes of the Court, but through a cinematographic exhibition. In these pictures a bubble of air, held in an inverted cup at the end of a glass rod, was shown in the act of being moved from place to place beneath the surface of the water contained in a vessel at the bottom of which rested various particles of mineral. The proposition was advanced by the plaintiff that particles of mineral oiled with amounts of oil such as would be attached to them when the proportion of oil was over 1% of the ore would not adhere to the air-bubble and therefore could not be floated by the bubbles in the form of a froth. This was coupled with the converse proposition that when the proportion of oil used was less than 1%, the mineral particles would adhere to the bubble and could be raised to the surface of the pulp. The plaintiff's expert made an estimate of the amount of oil that would adhere to the mineral particles when more than 1% was used and also when less was used. Proceeding on this basis, he applied oil in varying amounts to metal discs and mineral particles in order to show that the particles carrying larger amounts of oil would not adhere to the air-bubbles, but that those particles more minutely oiled would adhere to the bubble; also that the particles not oiled at all would likewise ad-

here. The experts for the defendant proved that the particles used in these experiments were several thousand times heavier than any mineral floated in a working process of froth-concentration. The experiments were repeated before the Court by the defendant's experts, who showed that the mineral particles adhered to the air-bubble regardless of the amount of oil on them. Particles of mineral were oiled by submerging them in oil and lifting them out coated with the maximum amount of oil that would adhere to them. These particles were then dropped into a vessel of water and the air-bubble applied to them, with the result that they instantly adhered to the air-bubble and were raised with the bubble when the bubble-holder was lifted. In short, these experiments either proved nothing or they proved that there was no particular virtue in the arbitrary limitation of the proportion of oil at 1%. In order to elucidate the technology of the process a large number of flotation operations were performed in Court. In these experiments various amounts of oil were used to demonstrate that the proportion of oil was not the decisive factor. In several instances the highest grade of concentrate and the best recovery were obtained when using oil up to 25% of the ore by weight. After each experiment the heading, tailing, and concentrate were assayed separately and the results put in evidence. All of this seems not to have impressed the Judge; he makes no reference to the bubble-holder experiments or to the flotation tests, although it is well known that the plaintiff was very proud of his moving-picture exhibit. In actual practice, it is known that the changing of the quantity of oil and of the kind of oil does have instantaneous effects, varying with the kind of ore that is being treated, but to us the whole argument is stultified by the fact that flotation has been performed on a working-scale while using an amount of oil ranging from tons to nothing, from the old Elmore process to that of Wood. It is the air that is the prime agent; the bubbles, not the oil. Bubbles can be made without oil; they can be made by using any one out of a thousand forms of hydro carbon that will modify the surface tension of water and promote selective floatability as between valuable mineral and valueless gangue. The weeds of the desert are as effective for that purpose as the oleic acid that perplexed Lord Haldane in the British court of last resort. Judge Bradford does not dwell on the fact that in any industrial operation the first requisite is to economize and that economy will necessarily lead to the use of the smallest possible proportion of any reagent as soon as the operation is conducted on a scale large enough to make cost an item of importance.

Another feature of the Wilmington decision is the validity assigned to patent 962,678, covering the use of a soluble 'mineral-frothing' agent—an idiomatic term, for it indicates an agent that makes a mineral froth, but it is intended to mean a substance that will make a froth capable of floating minute particles of mineral. This method, or phase of the flotation process, does not involve the use of 'oil,' but it does include the use of acid. Judge Bradford recognizes that frothing agents had

been used previously in ore concentration, "but not in the absence of an oily ingredient." Immediately after saying this he makes the significant remark: "Even were the grounds on which the validity of the patent can be sustained less clear, it should have the benefit of the presumption of validity arising from the grant of letters." We submit that such presumption is not customary because patents are granted notoriously on a showing so inadequate to prove invention that the validity of a patent has to be decided not by the Patent-Office but by the Courts of Law. No specific proportion of the frothing agent is mentioned in patent 962,678, therefore somebody ought forthwith to patent the use of, say, 0.1% or one-tenth of one per cent of a soluble frothing agent and proceed to invalidate patent No. 962,678, which otherwise will be a further hindrance to the free operation of the flotation process. We expect to see oil discarded in the near future in favor of some cheaper modifying agent, and we would like to see this great metallurgical process freed from litigation, embargo, and imposition. For such freedom we look to the Supreme Court, not because we wish to deny to Minerals Separation any revenue that may rightly belong to that proprietary but because we believe that to Frank Elmore and Alcide Froment the miner owes the greatest process of concentration as yet devised by man. We have read the testimony given in the various trials and other records covering the obscure story of the flotation process from its lame beginning to its triumphant demonstration. From a reading of this evidence we conclude that Alcide Froment became interested in the subject through seeing the Elmore bulk-oil method at the Traversella mine, in Italy, and that his subsequent modification, introducing "gas of any kind" into an oiled pulp, was the link between the bulk-oil and the frothing process, not the miserable granulation method of Cattermole, that wretched failure from which the Minerals Separation people claim to have found their way to successful froth-flotation. The elaborate story of the directions given to Mr. Higgins, by which he rang the changes on varying proportions of oil, acid, water, temperature, and so forth, has never impressed us as a convincing explanation of the jump from the sinking granules of Cattermole to the floating froth of \$35,120. That Minerals Separation should have been the proprietors of Cattermole's American patent and that their purchase of Froment's British patent gave them no rights in America is a coincidence that it requires no psychologist to appreciate. Moreover, after Froment, but before Sulman, Picard, and Ballot's chief patent, came Elmore's vacuum patent, in which the use of air, with oil, was introduced. This patent and No. \$35,120 have never yet looked horns. The litigation between Elmore and Minerals Separation has been based on the old bulk-oil process, not the later air method. The American rights to Elmore's vacuum-oil process were acquired last year by a syndicate associated with the Miami, Ray, and other big copper companies. That issue remains to be tried. We see no end to the litigation.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Prospects and Prospector

The Editor:

Sir—Having read with a great deal of interest the articles relative to 'Speculation in Mines,' 'Prospecting,' 'Financing Mining Operations,' etc., printed in the MINING AND SCIENTIFIC PRESS during the past several months, and appreciating the fact that such discussion can only result in a beneficial influence if continued in a frank and courteous manner, I offer some ideas and conclusions resulting from my experience. Before proceeding further, I wish to state that I have no "chronic prejudice" toward either the prospector, the engineer, or the investor, for a narrow-minded attitude of one toward the other is to be deplored. There are intelligent prospectors as well as intelligent engineers and investors.

The present-day attitude of the prospector toward the engineer and investor is largely due to the fact that the engineer examining prospects does not, or will not, advise his employer to assume any of the risk of exploiting the prospect, but does not hesitate to intimate to the owner of the prospect that he is expected to do so. Again, the engineer may spend a day, a week, or longer, examining a prospect and then try to tell the owner things that he already knows are not true, from his own experience in carrying on the development of his own prospect extending over a period of one to ten years.

The average engineer falls short of the standard the prospector is justified in expecting of him, especially if he is a graduate of a mining college. His inability to say what will occur in future development, and in many instances to see or grasp the indications present in prospect-work or on the surface (usually clear to the prospector's practised eye, especially if he has spent much time in the locality) causes the prospector to wonder how the engineer has profited from his technical learning. It does not take much of an engineer to tell what has happened or whether the mine is worth the price asked after it has been developed with shafts, tunnels, drifts, cross-cuts, raises, etc., of sufficient depth and extent to prove the mine. Engineers should realize and appreciate these matters.

How many engineers examining prospects today for investors could or would have expended the same work, time, or money; or who have the actual ability even to have found many of the orebodies they are judging? A 'trace' means nothing to many engineers, yet practically every or body throws a trace by which it may be found, and in many cases it is all the prospector has to guide

him in his discovery of what may or may not be a valuable mine.

The prospector can judge from panning the surface dirt whether the 'trace,' if there is one, is worth following, whether it is likely to have come from a vein, a pocket, or a tale or clay seam, and the length of ore-shoot on the surface; in many instances he can also tell what the walls will probably be and the strike of the vein, the character of the ore, about how far it is to whatever is "throwing the trace." In addition, his observation is much keener than the engineer's, the slightest change of formation as indicated on the surface or underground does not escape his observation. This, of course, is only natural as he is constantly watching. This ability should also be realized and appreciated by the engineer, as it is from these hints that mines are discovered.

Regarding the sale of prospects, I do not agree with some of your correspondents that "an engineer cannot be too cautious." I do, however, think an engineer should exercise sound judgment, backed by experience, and protect his employers in every way that is fair and legitimate. There should be just as much responsibility, however, in turning down a prospect as there is in recommending one, but such is not the case; an engineer may fail to fulfill his duty to his employer and the mining industry by turning down a prospect, with little fear of reprimand, as he is only held accountable for those he recommends.

Nine out of ten prospects are turned down in the engineer's mind before he leaves the office (I also have been guilty of such an indiscretion), so that the gossip of the local 'knockers' club' may fit well with the engineer's prejudiced opinion. Anybody can turn down a prospect; it takes nerve to recommend one.

While it is contended by some of your correspondents that probably less than 1% of the prospects prove to be mines, I have not found such to be the case; nor do I believe such is the case provided 'boom camps' are eliminated (as they should be in such a summary) and only intelligent and legitimate prospecting taken into consideration. No intelligent prospector would waste the trouble, time, and development necessary to make a prospect worthy of examination unless it is, to say the least, encouraging.

Some prospectors, engineers, and investors should be digging potatoes or raising a garden rather than trying to enter the mining business, or, in other words, they are not what they claim to be. A man engaged in the

the revolving cathode, a drum covered with sheet-copper revolving in a bath of mercury about $1\frac{1}{2}$ inches deep, connected with the negative pole of the dynamo. The earliest style of cathode roller was ratchet shaped, with strips of copper fastened to it with screws. *F* is the earliest type of anode, which consisted simply of sheets of iron connected with the positive pole of the generator and suspended above the cathode. *D* is a shaking

rollers when the machine was shut-down, the electrolytic cells being out of use during the time employed in filling and discharging the tank; it was also found impracticable to keep up continuous agitation and carry on precipitation at one operation in the arrangement shown in Fig. 1.

After various experiments the arrangement shown in Fig. 2 was evolved, which was very satisfactory and quite a metallurgical success. It was substantially the arrangement of the Garvin plant as installed in the St. Paul mill in Sonora, Mexico. This was one of the most efficient silver-cyanide plants of its size and time. There were three agitators *A*, one settling-cone *B*, six precipitating-cells *D*, two battery-solution tanks *E*, and three sand-agitating pumps *F*. *G* is the solution-pump. Of course, their agitator was too expensive in pump-wear and power-consumption to compete with such modern devices as the Pachuca or Trent or Dorr machines of the present day. Their precipitating device is the only thing of any interest now.

If such a machine were operated along with a modern

copper plate arranged in steps, the flat part of the steps being connected with the negative wiring as a cathode, while the drop between steps had iron strips connected with the positive pole as an anode. The pulp and solution flowed over this in the process of agitation. This arrangement was all right on the black-sand machine on the Snake river, but generally there was such a scouring that it was eventually abandoned. No particular benefit was obtained by the electric connections on the amalgamating device. *E* is the centrifugal pump that agitated the charge, by pumping the material from the bottom of the cone-tank, mixed with the thin barren solution from the precipitating-cells which was pumped back into the top of the tank and thus kept in circulation. The aim was to keep agitation and precipitation going on at the same time, so that when extraction was complete, precipitation was also finished; then the charge would be allowed to settle, the solution and one wash-water would be decanted and then the pulp was discharged through the bottom.

This arrangement worked very well in the small machines in the test-plants, but in practice on a working scale various objections developed. The ends of the anodes would corrode and their renewal meant a considerable waste of iron, so the design was changed to that shown in Fig. 3. *A* on Fig. 3 was the final form of anode used by the Garvin people. They also had trouble from mud collecting in the boxes and sticking to the

Trent displacing-machine, a Vandercook filter, or a Dorr continuous decanting process, it would no doubt be a great success. Fig. 3 illustrates their best form of precipitating-cell. *A* is the anode, which also acts as a baffle, forcing the solution between anodes *A*, and *D* the

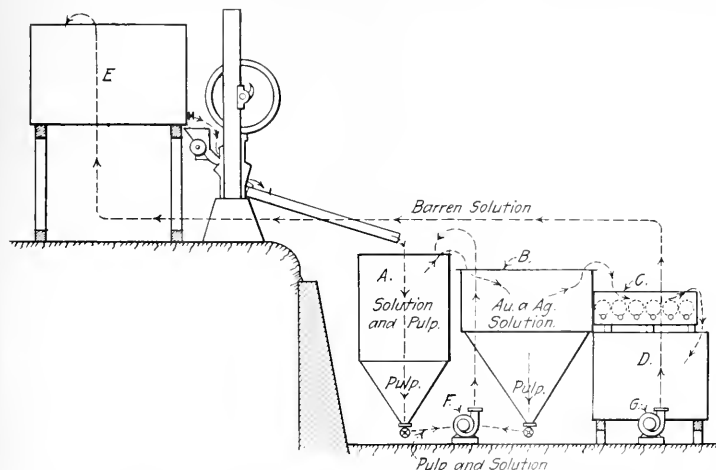


Fig. 2. A later Garvin flow-sheet. *A* is the agitator; *B* is the settling and clarifying cone; *C* is 6 electrolytic cells in series in a cement box or tray; *D* is the sump; *E* is the battery-solution tank; *F* is the agitation-pump; *G* is the solution-pump. This was built in 1907.

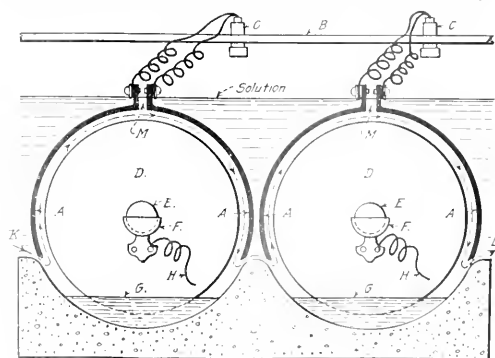


Fig. 3. The last and best type of Garvin cell arrangement in a shallow cement vat. *A* is the anode; *B* is the buss-bar transmitting positive current from generator; *C* is a cup of mercury by which positive wire from anode is connected; *D* is cathode roller revolving 20 r.p.m.; *E* is a brass wheel revolving in the mercury cup *F* and connecting (by negative wire *H*) the cathode with the generator; *G* is a mercury bath; *J* is cement bottom; *K* is solution inlet; *L* is solution outlet.

cathode. The anodes employed in all the working-plants were of iron, though some experimental work was done with peroxidized lead anodes at the testing-plants and it was expected to adopt them in the larger plants shortly. *B* is a buss-bar connecting the anodes with the positive pole of the generator. *C* is a cup of mercury on the buss-bar, in which wires connected with the anodes are inserted, making a quick and positive connection. *D* is the cathodic roller with a surface of sheet-copper, revolving in a mercury bath, *G* presenting a fresh clean surface to the precipitating field at each revolution. *E* is a brass wheel on the roller-shaft, which revolves in the mercury-cup *F*, connected with the negative wire *H*. *J* is the box in which the cell operates. They were about 5 ft. long and large enough for a roller 18 in. diam. Those built of portland cement, after the manner of laundry-trays, gave best results. *K* is the solution inlet, *L* the solution outlet, and *M* the hydrogen escape. Precipitation took place as readily when the solution was muddy as when it was clear, so long as it did not choke the box. With rich solutions amalgam accumulated on the roller in ridges; with lean solutions it washed off into the mercury bath as fast as formed.

When any considerable quantity of sulphide concentrate accumulated in the precipitating-cell, it tended to sicken the quicksilver, so it was better to partly clarify the solutions before the concentrate entered the field. Ten volts and one ampere per square foot of anode surface proved to be the most satisfactory current to use. The assay results are not now at hand, but I remember distinctly that with the six standard cells in series, there was no trouble in precipitating 75 tons daily of \$3 solution, so that the tailing would assay below 20 cents.

The clean-up was an easy matter. The current was shut-off. The solution was replaced with water, which was heated to boiling with live steam, while the roller was set in motion, and most of the amalgam would come off into the mercury-bath. The mercury would be drawn out and allowed to stand a few hours; then it was squeezed through a chamois skin; the drum was scraped with a rubber, the amalgam retorted, and the sponge melted into bricks. Low voltage generators built by the Crocker-Wheeler Co. were used.

When we were working the Garvin precipitating process, we were learning all we could of the results obtained by other electrolytic processes. It was observed that we were doing the work with not over one-tenth of the metal electrode surface as employed by either the Siemens & Halske or Butters processes. It was at first thought that the difference was due to the new mercury coating deposited on the revolving cathode at each revolution, making a fresh bright surface, but it seems more probable that the mere revolving of the drum presented the same surface many times to the solution and was thus equivalent to many times larger cathode surface; and it is pretty generally agreed that the rate of precipitation is largely dependent on the number of times the electrolyzed solution is washed past the cathode independent of the anode, the only function of which is to transmit the

current. The Garvin revolving drum moved in an opposite direction to the flow of the solution, making conditions for rapid deposition still more favorable.

When these experiments were commenced in 1904 it was thought necessary to increase the cyanide strength of solution to 3 pounds KCN per ton before sending it to the zinc-boxes in order to accomplish a satisfactory precipitation, even though a 1-lb. solution was sufficient to extract the precious metals. No one was making much of a success then in treating slime. The arm-agitator was the best thing that had then appeared. Under such conditions, such a method as has been described would be attractive in many places. But after the situation had cleared, following the 1907 panic, when the directors of the company sought to revive it, it did not appear to me a desirable thing to invest money in, for the Pachua, the Dorr, and the Trent agitators were firmly established. The Moore filter, the Merrill press, and the Butters plants were a success on slime-treatment, and the zinc-lead couple had overcome most of the precipitation troubles. Most of the relatively small operators with whom I was associated had little interest in a process that could only offer precipitation at an equal cost, particularly as it called for a large initial outlay in copper, mercury, and electrical equipment which would require skilled operatives on each shift. With the cost of zinc precipitation doubled, all this is changed. I believe, though, that anyone interested in electrolytic precipitation who does not recognize the importance of a moving cathode is overlooking a good bet.

Dolomi, Alaska, September 23.

E. C. MORSE.

Pipe-Capacity

The Editor:

Sir: In "Concentrates" in your issue of September 30, you stated "doubling the diameter of a pipe increases its capacity four times."

The accuracy of this statement is governed by what the Editor wishes us to understand by 'capacity.' As an admirer of the editor's advocacy of precision in expression I assume that 'capacity' as used is intended to be the capacity of a pipe to carry or discharge water, and not its capacity as a container or reservoir. It requires only a little reflection to understand that one 4-inch pipe will carry more water than four 2-inch pipes, because although the area of one 4-inch pipe is exactly equal to that of four 2-inch pipes, the amount of metal in contact with the water in the four 2-inch pipes is exactly double that of the one 4-inch pipe. The circumference of four 2 inch pipes is 25.1328 inches and of one 4 inch pipe 12.5664 inches. This reduces the friction in the 4 inch pipe.

As a general statement the carrying capacity of pipes, other conditions being equal, varies as the 2½ power of the diameter; therefore, doubling the diameter of your pipe increases its capacity 5.657 times instead of four times.

R. D. PERKINS.

Los Angeles, October 11.

A Graphic Method for Correcting Steel Tapes

By Walter Scott Weeks

*The errors that occur in measurements with a steel tape are due to four causes:

- (1) Stretching due to tension, induced by pull.
- (2) Shortening, due to the sag of the tape.
- (3) Variation in temperature from a standard at which the tape is correct in length when no pull is exerted.
- (4) Poor manipulation.

It is the purpose of this paper to develop a method by which the work of calculation of the errors of the first three types may be reduced to a minimum.

THE PROBLEM. The tape is often used horizontally, and the distance measured in multiples of 100 feet. Rather more complicated taping is done in mine-work. The measurements are taken from the head of the instrument along the line of sight to some definite point. The tape in use may be of any length and it may be at any angle with the horizontal. These facts prescribe that the system of correction, if it is to be comprehensive, must embrace the conditions of any length of tape and any angle of inclination.

It is the custom to hold the portion of the tape that is at the sighted point at the nearest foot-mark and to read the fractions of a foot at the instrument. The spring-balance that measures the tension must be attached to the ring on the tape at the instrument. This fact demands that the tension shall be measured at either the lower or the upper end of an inclined tape, for sometimes the shots will be inclined downward and sometimes upward. The tape must be standardized at some particular pull and temperature, and this standardization must be taken into consideration.

In order that the field-work may not be complicated, the requirement should be made that on any particular tape only one pull shall be exerted under all conditions.

The problem may be stated in another way:

A tape is sent to the Bureau of Standards and standardized. The tape is used in the field with a certain computed pull and the temperature is noted.

A chart is to be constructed from which can be taken in one operation the combined errors in the measured distance due to any cause whatsoever.

PULL. The pull to be exerted on the tape shall be 2000 times the weight of the tape per foot. This pull will hereafter be designated as the 'working pull.'

LIMIT OF ACCURACY. The method of making the correction will now be developed, and it will be seen that the correction will be given with an error not greater than 0.01 ft. The corrections will apply to any length of steel tape up to 200 ft. The corrections are com-

puted for steel having a density of 0.283 lb. per cubic inch, a modulus of elasticity of 29,000,000 lb. per square inch, and a coefficient of linear expansion of 0.0000065 per degree Fahrenheit.

STRETCH. The formula for the stretch of a horizontal tape is

$$e = \frac{P L}{S E}$$

P = pull in pounds

L = length of the tape in feet

S = area of cross-section of tape in square inches

E = modulus of elasticity = 29,000,000

e = elongation in feet

Let W = weight of 1 foot of tape.

Let w = weight per cubic inch of tape metal = 0.283 lb.

If the working pull is substituted in the formula it becomes

$$e = \frac{2000 W L}{S E}$$

$$W = 12 \times S \times 0.283$$

$$e = \frac{2000 \times 12 \times S \times 0.283 \times L}{S \times E} = 0.000234 L$$

$$e = 0.000234 L$$

This is the stretch when the working pull is exerted on a horizontal tape. It is now necessary to investigate the effect of the weight of the tape on the stretch when the tape is inclined.

Obviously the weight of the tape will exert its maximum effect when 200 ft. are in use and the tape is hanging vertically. The stretch then due to the weight is

$$e = \frac{T L}{2 S E}$$

where T is the weight of the tape in use.

Substitute for T the value $L \times S \times 0.283 \times 12$:

$$e = \frac{S \times 0.283 \times L^2 \times 12}{2 \times S \times E} = 0.00234 \text{ ft., when } L = 200$$

The effect of the weight of the tape will always be less than this because the tape will be inclined at a less angle. Hence we may say that as far as the stretch correction is concerned the pull may be measured at either the upper or the lower end of the tape.

The straight line may now be drawn that represents the equation

$$e = 0.000234 L \text{ (see chart)}$$

The ordinates show the error caused by stretch for all lengths and inclinations of the tape.

SAG. Professor E. V. Huntington of Harvard University has developed a method for computing the length of the chord of the catenary curve assumed by a tape that is supported at the ends.* The formula and a portion of the table are herewith printed.

*This article will also appear in the University of California publications in engineering.

*L. S. Marks, 'Mechanical Engineers' Handbook,' p. 150.

NOMENCLATURE:

 θ = inclination of tape W = weight of tape per unit of length L = length of tape in use P = tension at upper end k = correction factor given by table corresponding to any given values of θ and n

$$n = \frac{WL}{P}$$

Length of chord = $L - kL$ PORTION OF TABLE FOR DETERMINING VALUES OF k

θ	n	0.05	0.07	0.08	0.09	0.10	0.11	0.12
9	0.000150	0.000204	0.000265	0.000337	0.000417	0.000505	0.000601	
19	147	209	262	323	412	509	596	
29	135	185	242	307	381	463	551	
39	116	158	208	265	329	401	480	
49	91	125	165	210	261	318	382	
59	65	90	118	150	186	226	272	
69	39	54	71	91	114	139	167	
79	19	26	34	43	53	65	78	
89	5	6	8	10	13	16	20	
99	0	0	0	0	0	0	0	

If we substitute for P the value of the working pull, the sag formula becomes simplified:

$$n = \frac{WL}{P} = \frac{WL}{2000W} = \frac{L}{2000}$$

Different values of L may now be substituted and the correction kL plotted for different inclinations of the tape. The ordinates of the curves show the error caused by sag for various lengths and inclinations of the tape.

When the working pull is exerted at the upper end of an inclined tape

$$n_1 = \frac{L}{2000}$$

when n_1 represents the value of n under this condition.

When the working pull is exerted at the lower end with a length of tape L in use and angle of inclination θ , the pull at the upper end will be $W(2000 + L \sin \theta)$, and

$$n_2 = \frac{L}{2000 + L \sin \theta}$$

where n_2 similarly represents the value of n under this condition.

The greater the difference in n in these two cases the greater will be the difference in the length of the chords with a constant angle of inclination, as is exhibited in the preceding table.

Change

$$\frac{L_2}{2000} \text{ to the form } \frac{1}{2000} \frac{L_2}{L_1}$$

and

$$\frac{L_1}{2000 + L_1 \sin \theta} \text{ to the form } \frac{1}{2000} \frac{1}{1 + \frac{L_1 \sin \theta}{2000}}$$

Hence

$$n_1 - n_2 = \frac{1}{2000} - \frac{1}{2000} \frac{1}{1 + \frac{L_1 \sin \theta}{2000}}$$

L_1 varies from 0 to 200 and $\sin \theta$ from 0 to 1. Hence for a given θ the two fractions in the right and denominator have a maximum difference when L_1 is a maximum, namely, 200 in value.

Therefore, with a length of tape 200 ft. assumed, if the difference in the chord lengths is calculated it is found as the angle of inclination is varied that at $\theta = 0$ the difference is zero, because the pull at both ends is the

same. With increasing angle the difference gradually rises to 0.006 ft. and then declines again and becomes zero at 90° , because at that point there is no sag. Thus within the limit of error, which has been established, it makes no difference whether the pull is measured at the upper or the lower end.

There still remains to consider the standardization of the tape and the variation in length due to changes of temperature.

STANDARDIZATION. The tape will be standardized supported throughout its entire length at a temperature T and a pull P . The length of the tape will then be calculated with no pull and under the above conditions of support and temperature. The temperature at which the tape is exactly correct in length with no pull and entirely supported will next be computed. This temperature is called the standard temperature for the tape. An example will illustrate the method of computing the standard temperature.

A 200-ft. tape is standardized at a pull of 10 lb. and 60° F. and found to measure 200.06 feet.

First. What will be the length at 60° F. with no pull?

Let W = weight of the tape per foot. When the working pull is exerted the pull = $2000W$. The stretch is directly proportional to the pull. Hence when a 10-lb. pull is exerted the stretch is

$$\frac{10}{2000W} \times \text{stretch with working pull}$$

The stretch with working pull may be taken directly from the chart and for this case is seen to be 0.047.

If the tape weighs 0.01 lb. per foot, the elongation due to 10-lb. pull is

$$\frac{10}{20} \times 0.047 = 0.024$$

Hence with no pull the length would be 200.036.

Second. At what temperature would the tape measure 200 ft. exactly?

The coefficient of expansion for steel is about 0.0000065 for 1° F. Two hundred feet will shorten 0.0013 ft. with a drop in temperature of 1° F.

To shorten the tape 0.036 ft. the temperature must be lowered

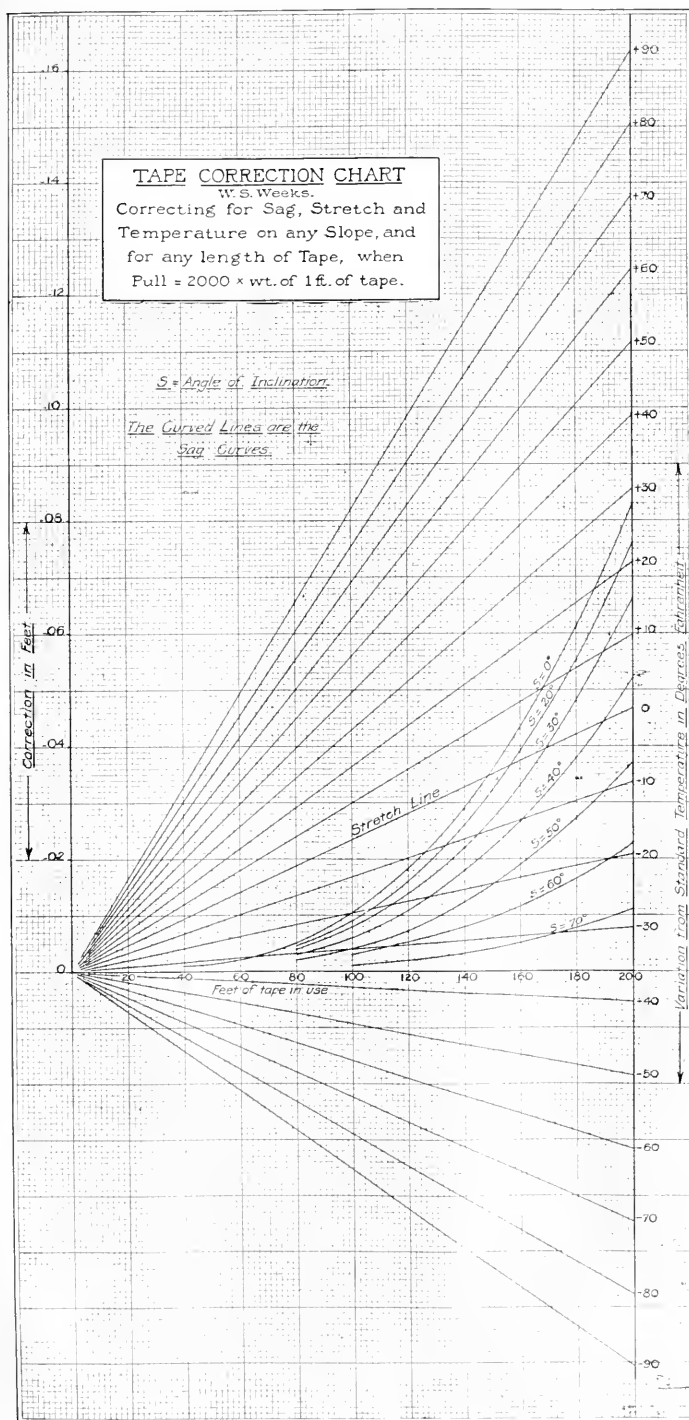
$$\frac{0.036}{0.0013} = 28$$

$$60 - 28 = 32$$

Thirty-two degrees is then the temperature at which the tape is correct in length with no pull and entirely supported.

For this particular tape 32° F. is the standard temperature and is represented on the chart as 0.

TEMPERATURE VARIATION. The variations in the length of the tape due to variations in the temperature from the standard temperature are plotted with the stretch line as the datum. The temperature lines are marked with the number of degrees by which they differ from the standard temperature. If the standard temperature be subtracted algebraically from the temperature at which the tape is used the variation in temperature will be given. The variation in length = length in use $\times 0.0000065$ variation in temperature. The



difference between the ordinate of a temperature line and the ordinate of the stretch line for a given length of tape gives the variation in length due to temperature.

METHOD OF USING THE CHART.
An example will now illustrate the method of using the chart.

A tape whose standard temperature is 32° F. is used when the temperature is 62° F. the angle of inclination is 60° , and the length in use is 160 feet.

The temperature is 30° higher than the standard. Place one point of a pair of dividers on the intersection of the temperature line marked $+30$ and the vertical 'feet' line marked 160. Place the other end of the dividers on the intersection of the sag curve marked 60° and the vertical 'feet' line marked 160. Transfer this distance to the vertical scale at the left where the correction is read. It is seen to be 0.057.

If the temperature line is above the sag line, the correction must be added. If the sag line is above the temperature line, the correction must be subtracted. This results from the fact that when the tape is too long the recorded distance is too small and when the tape is too short the recorded distance is too large.

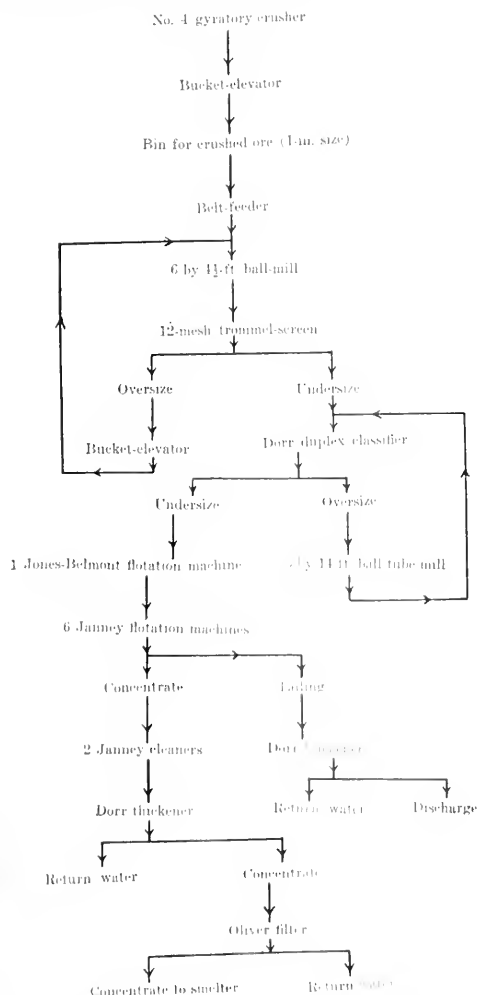
In the present instance, 0.057 must be added.

SUMMARY OF METHOD. Compute the temperature at which the tape is correct in length with no pull and entirely supported. This is the standard temperature. Use the tape with a pull which equals 2000 times its weight per foot. Subtract algebraically the standard temperature from the temperature at which the tape is used to obtain the "variation from standard temperature." Place one point of a pair of dividers on the intersection of the temperature line and the length line and the other point on the intersection of the sag line and the length line, and transfer this distance to the scale at the left where the correction is read in feet.

Flotation at the Florence-Goldfield Mill

By H. B. Clapp

The Florence mine at Goldfield, Nevada, was equipped in 1909 with a 40-stamp mill and cyanide plant, which was burned in 1912. Since then the mine has been operated for a small tonnage of shipping ore, during the extraction of which a considerable quantity of low-grade gold-copper ore was developed. Flotation has made its local treatment profitable, and a mill to treat the ore is giving satisfactory results from the following scheme of treatment:



The average extraction is 90% on a comparatively low-grade ore containing gold, silver, and copper.

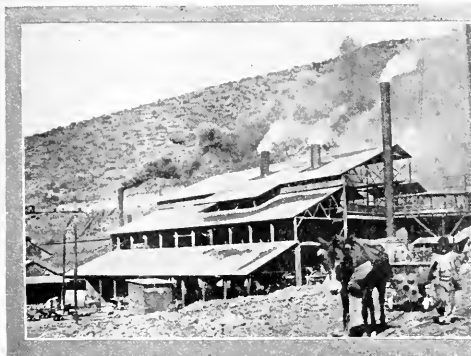
*Mill manager.

The Jones-Behnmont machine, which works ahead of the six Janney machines, is a new type on the market, having been designed and patented by A. H. Jones of the Tonopah Behnmont Development Co. This standard-sized cell was installed in the Florence flotation plant at the request of Mr. Jones, in order that full data might be obtained under regular working conditions in comparison with the standard Janney apparatus. The Jones-Behnmont has been taking the whole mill-feed of from 150 to 180 tons, and has made a higher-grade concentrate, with a lower silica-content, than the shipping concentrate taken from the two Janney machines, which clean the rougher concentrate from the six Janney machines that make a rougher concentrate. The new machine not only requires less power, but also less labor, and less oil per ton of ore to make a better extraction. The company is considering installing this type of machine in the flotation end of the mill.

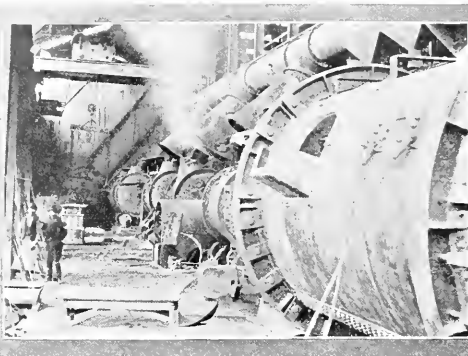
Nickel-Steel

The span of the Quebec bridge that was lost during September contained 5200 tons of nickel-steel. The loss is estimated at \$600,000. This material is a decided specialty when compared with ordinary carbon-steel. In fixing a price for nickel-steel the rule is to add \$12.50 per ton for each 1% of nickel added. This must be open-hearth. The standard specifications of the American Society for Testing Materials for structural nickel-steel and rivet nickel-steel say that the nickel shall not be under 3.25%. Steel firms usually like to get about \$12 for fabricating and \$12 for erection, but the charges for this work are governed to a great extent by competition, etc. Erecting in an out-of-the-way place would command a higher figure. The fabrication and erecting costs, of course, are added to the mill price of the steel. Freight must be calculated also. Structural steel today, that is, shapes, is around 2.75c. per lb., Pittsburg. Plates are quoted at 4c., and bars at 2.75c. Prompt deliveries command premiums. The material which went into the Quebec bridge was bought at lower prices than prevail today. The Memphis bridge over the Mississippi was constructed of Mayari steel, a natural nickel-chrome steel.

THE chemical difference between sodium and potassium nitrate is in the character of the basic metal. As indicated in the names of these compounds, the metal in the one is sodium and in the other, potassium. Sodium nitrate, or Chile salt-peter, is imported into this country in large quantity from Chile. The potassium or potash nitrate has come chiefly from Germany, which controls the world's potash supply. It is practically impossible to obtain potash salts of any kind at the present time and quotations on potassium nitrate (niter) have not been published for a long time. Owing to the great demand for Chile salt-peter the price of this commodity has greatly increased and it is now bringing approximately \$1 per 100 pounds.



THE SMELTER.



THE OLD CONVERTERS AND THE NEW.

The Naltagua Smelter

By Mark R. Lamb

Experiments were made some time ago at Gatico to determine the possibility of converting matte in small acid converters, by lining them with basic brick. George W. Waters made a success of this, and it tempted others to make the trial. The manager at Naltagua decided that it was economy to use the basic converter designed by Pierce & Smith, but meantime he experimented with their smaller acid converters provided with basic brick lining. In this plant, the acid lining had given much trouble, on account of the difficulty of finding lining material at all suitable. The results attained with the acid converters with basic lining, although not as satisfactory as those obtained with the converter designed specially for the process, were an improvement over former practice, and these furnaces are still being operated basic, until the installation of the Pierce & Smith converter is completed.

The smelter makes about 15 tons of copper per day, and at the present high price of that metal, is making handsome profits. The sudden rise in the price of coke decided the management to install reverberatory furnaces to burn pulverized coal, since the Chilean coal is of a good quality and there is no great demand for slack. These furnaces have been on order some weeks and are beginning to arrive. Foundations are being prepared and it is expected that they will be blown-in within six months. This period seems long, compared with the time required for such installations elsewhere, but Chile is a long way from the machinery factory, and labor is none too abundant and is unskilled in such work.

The new plant is complete in every detail: it includes a drier, pulverizer, and ball-mill for reducing the coal to 150-mesh and finer. The ore also must be dried, and will be crushed to a fineness depending on the relative price of coal and coke; in other words, with cheap coke, it

will pay best to send as much as possible of the ore to the blast-furnace, whereas when coal is relatively cheaper than coke, the crushing will be finer, and a larger proportion of ore sent to the reverberatories.

It is expected to obtain a smelting ratio of seven of ore to one of coal. The pulverized coal will not be stored in large quantities, in order to avoid the danger of spontaneous combustion in the bins. Both the coal and the ore will be dried to under 2% moisture, in order to reduce fuel consumption in the reverberatory furnaces.

The plant is so arranged that the matte from the water-jacketed furnaces will be laundered direct from the fore-hearths to the converters, while the matte from the reverberatories will be hauled by an electric locomotive to within reach of the converter-crane and thus charged into the converters. It is planned to take the slag away intermittently in cars, but when water is plentiful, this slag will probably be granulated. Formerly, and until the available space was all filled up, it was the practice to granulate the slag from the water-jacket furnaces, but it has been found necessary to resort to cars, mules, and boys.

When the new furnaces are in operation, smelting with the cheapest fuel available and with cheap power from waste gases, using the Pierce & Smith converter, this plant will be completely up-to-date and will smelt at as low a figure as any plant in South America.

THE LARGEST STEEL CHIMNEY in the world is that at the United Verde Copper Co.'s smelter at Clarkdale, Arizona. The stack is 400 ft. 1 in. high, 30 ft. 9½ in. diam., and is lined with 4 in. of brick throughout.

TUNGSTEN ORE is being mined near the Miramichi river in New Brunswick. A 20-ton mill is at work.

The Wet Treatment of Copper Concentrate

By Lawrence Addicks

*A complete wet process† consists of roasting and leaching the calcine in dilute sulphuric acid produced from the roaster-gases, roasting the residue with salt, and leaching with dilute tower-liquors (the well-known Longmaid-Henderson process) and recovering the copper, silver, and gold by cementation or electrolysis or a combination of both. It is evident, however, that the residue from the first leaching, carrying about 20% of the copper and all of the silver and gold, can be smelted if preferable. In considering the application of the scheme to individual cases, it must be remembered that freight plays a large part in any reduction process wherein smelting is not conducted at the mouth of the mine, and that it is not practicable today to build small smelting-plants for individual operations.

The experiments may be grouped under four main heads: roasting, leaching, chloridizing residue, and recovery of copper solutions. The products of two concentrators were used: the Nacozari concentrate was the product of a large modern mill not using flotation, the copper mineral being largely chalcopyrite; and the Tyrone concentrate, the product of an experimental mill, including flotation, the copper mineral being chiefly chalcocite. Typical analyses would be as follows:

	Nacozari	Tyrone
Copper, per cent	14.0	14.0
Silver, ounces per ton	4.0	0.5
Gold, ounces per ton	0.01	Trace
Iron, per cent	31.0	28.0
Sulphur, per cent	34.0	30.0
Silica, per cent	13.0	...
Alumina, per cent	3.0	...
Lime	0.6	...

The Nacozari concentrate carries considerable coarse jig-product while the Tyrone material comes from an ore where the copper is finely disseminated and the quantity of 100-mesh is quite marked. The presence of the flotation-concentrate in the Tyrone material brings up the copper content of the fine.

ROASTING. The object in roasting is to make as much of the copper and as little of the iron as possible soluble in dilute sulphuric acid. The work is similar to roasting fine pyrite in sulphuric acid manufacture except that this solubility ratio rather than the complete utilization

of sulphur is the controlling factor. Small-scale work is not satisfactory as a guide to possible results because it is practically impossible to prevent over-heating due to rapid oxidation of sulphur in a laboratory experiment.

An 18-ft., water-cooled, six-hearth McDougall furnace was used, the speed of rotation being gradually cut down until 'dead roasting' conditions were obtained.

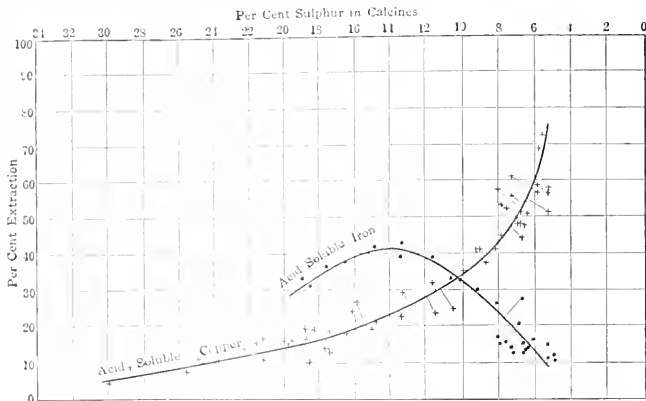


FIG. 1. NACOZARI CONCENTRATE ROASTED IN 18-FT. SIX-HEARTH FURNACE AND LEACHED IN 4% SULPHURIC ACID IN LABORATORY.

Greater tonnages could doubtless have been obtained in a seven-hearth furnace.

Many samples were taken from various hearths and the acid-soluble copper and iron determined by leaching with 1% sulphuric acid in the laboratory. It is evident that the chalcocite can be oxidized much more readily than the chalcopyrite, although size of particles has something to do with this. An investigation of the solubilities of the various sizes of particle was carried out by screening some of the calcine, as shown in Fig. 3. As would be expected, the finer particles are the more thoroughly oxidized; the jig-product in the Nacozari concentrate is one reason for the poorer results obtained in the treatment of this material.

In general, these large-scale experiments indicate the possibility of reasonably obtaining the results desired—high copper and low iron solubility—but it is obvious that the residue after leaching will contain sufficient copper to require re-treatment, aside from the fact that any silver and gold will remain in this residue.

LEACHING. As shown in the paper presented last year, such satisfactory results in the extraction of copper from firing were obtained by dumping the hot calcine from the furnace into a leaching-trough, the few

*Abstract of paper presented at the Arizona meeting of American Institute of Mining Engineers (September, 1916).

†Patent applied for.

seconds agitation thus obtained extracting almost as much copper as prolonged treatment in other apparatus, that the same idea was tried out with the concentrate calcine. It was not possible, for various reasons, to handle the output of the furnace directly, so the calcine was stored and then fed to a bucket-elevator which in turn delivered into a V-trough in which the leaching-liquor was flowing. The results were here disappointing, as although there was instant extraction of perhaps half of the soluble copper, a prolongation of the trough to

which would artificially increase the iron taken into solution.

EXTRACTION BY HEADING *v.* TAILING

	Weight, —Copper—		—Iron—		Alumina	
	Lb.	%	Lb.	%	Lb.	%
Heading	8360	15.48	1292	31.00	2590	5.60
Tailing	5600	3.50	196	43.52	2440	7.02
Extraction		84.70	1096	5.80	16.00	75
Extraction per lb.						
of Cu		1.00		0.14		0.07

EXTRACTION BY ANALYSIS OF LIQUORS

	Weight, —Copper—		—Iron—		Alumina	
	Lb.	%	Lb.	%	Lb.	%
Heading	51,538	0.46	238	0.20	140	0.47
Tailing	86,910	1.46	1271	0.76	657	0.45
Extraction		80.00	1033	21.30	553	31.90
Extraction per lb.						
of Cu		1.00		0.53		0.14

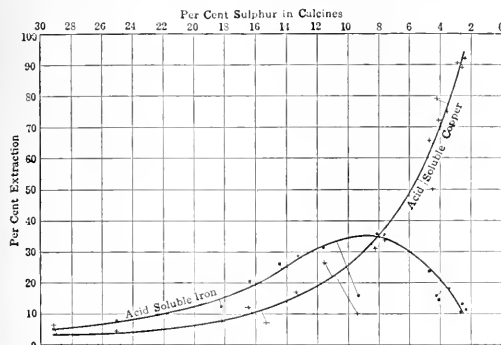


FIG. 2. TYRONE CONCENTRATE ROASTED IN 18-FT. SIX-HEARTH MCDUGALL FURNACE AND LEACHED IN 4% SULPHURIC ACID IN LABORATORY.

give 60 sec. travel did not greatly increase this amount. It was definitely shown in the laboratory as well that prolonged agitation was necessary to extract all of the soluble copper. The leaching-trough delivered into an acid-proof drag consisting of an endless belt with angle rakes, of the type commonly used in concentrators for dewatering. This acted more or less as a classifier, the very fine residue being carried over with the liquor, from which it was subsequently separated by settling. As this still gave insufficient agitation to the sand, a Parral agitating-vat was tried, but it was found that the material was too heavy to yield readily to any sort of air-lift agitation. A Dorr classifier was then added to the apparatus and this did better. It was found, however, that it was necessary to pass the residue six or seven times through the leaching process in order to obtain an extraction equal to that shown by laboratory tests on the calcine.

The large-scale leaching tests were confined to the Tyrone material, a lot of 30 tons of calcine from some of the roasting tests being used. The first runs on a lot of 17 tons of not quite 'dead-roasted' material containing 4% sulphur gave results that were satisfactory except in that too much iron was dissolved, causing a needless consumption of acid and embarrassing any electrolytic scheme of recovery. Later, better-roasted material was available and a careful record kept of the metal balance and acid consumption.

These figures check reasonably close except in the case of iron; but it must be remembered that various iron parts in the apparatus used were attacked by the liquor,

The acid consumption was 2495 lb. of 100% sulphuric acid for the run. This is equivalent to 2.28 lb. of acid per pound of copper extracted. Laboratory tests on the same calcine indicated a consumption of 2.0 lb. The leaching was done at about 125° F. with 5.6% free acid in the liquor entering the trough. The residue was passed through the leaching process five times.

In general, when a 15% copper calcine is fed to the trough, the residue at the end of the trough will contain about 8% Cu, the extraction representing the instantaneously soluble copper. This residue can be brought down to about 3.5% Cu by suitable agitating means, with a consumption of a little over 2 lb. of acid per pound of copper, and with the extraction of but little

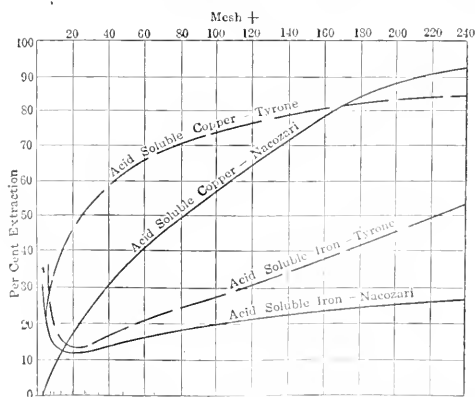


FIG. 3. RELATIVE SOLUBILITIES OF VARIOUS SIZED PARTICLES OF CALCINE.

iron. The final residue weighs about 60% of the original concentrate before roasting.

CHLORIDIZING RESIDUE. No large-scale work was done on the chloridizing of the residue from the first leaching. The analysis of this residue, however, differs from that of pyrite cinder, so long successfully treated by this process, only in the amount of silica present. Various small-scale experiments were tried and 50 lb. or so was sent for test to a plant where the Longmaid-Henderson

process was in operation. Both sets of experiments were entirely satisfactory.

A small lot of the leached residue was prepared for test. This contained 5.6% Cu, 1.9 oz. Ag, and 2.5% S. Raw concentrate for adjusting the sulphur-copper ratio was used, containing 14.4% Cu, 0.55 oz. Ag, and 31% S. Fig. 4 shows the extractions with varying percentages

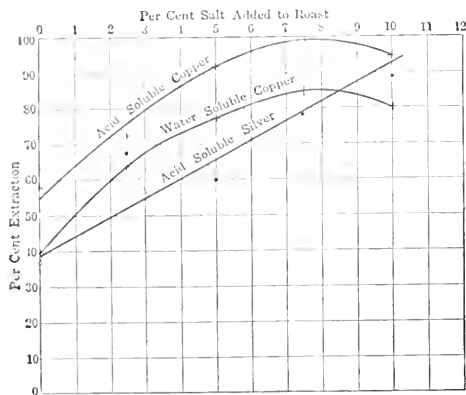


FIG. 4. CHLORIDIZING LEACHED CONCENTRATE CALCINE.

Roasted $1\frac{1}{2}$ hr. at 975° F. with addition of salt and 10% raw concentrates.

Calclines: 5.6% copper, 1.9 oz. silver, and 2.5% sulphur.

Raw concentrates: 14.4% copper, 0.55 oz. silver, and 31% sulphur.

Liquor: 5% Na_2SO_4 , 5% NaCl , 5% FeCl_2 , and 0.5% $\text{HCl} + \text{H}_2\text{SO}_4$.

of common salt added to the 'mix' after roasting in an electric muffle furnace $1\frac{1}{2}$ hr. at 975° F. and leaching in a liquor carrying 5% Na_2SO_4 , 5% NaCl , 5% FeCl_2 , and

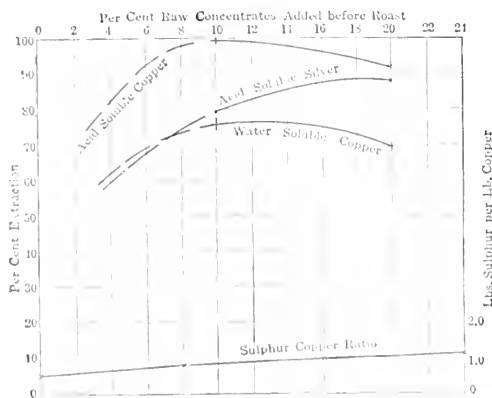


FIG. 5. EFFECT OF SULPHUR-COPPER RATIO UPON EXTRACTION. 7% SALT ADDED TO ROASTING 'MIX'.

0.5% $\text{HCl} + \text{H}_2\text{SO}_4$. Fig. 5 shows the effect of varying the sulphur ratio. The results show an extraction of 98% of the copper and 79% of the silver. The report on the lot of residue sent away fully confirmed these results.

RECOVERY OF COPPER FROM SOLUTIONS. The liquor from the chloridizing plant would doubtless be reduced to argentiferous copper-cement by iron. But 20% of the original copper is involved. The sulphate liquor from the first leach could be precipitated on iron if desired, or with certain limitations would be suitable for electrolytic deposition of the copper and regeneration of the acid. The concentrate carries from 1 to 2 lb. of sulphur per pound of copper, equivalent to from 3 to 6 lb. of 100% sulphuric acid, less process losses, if the roaster gas is oxidized to sulphuric acid. Since the leaching calls for but a little over 2 lb. of acid per pound of copper, plus tailing losses, it would seem possible, therefore, to figure on a simple cementation plant, considering electrolysis as a competitor on a basis of relative profit and not of necessity.

World's Record in Shaft-Sinking

The record was made in the month of August at the Chief Consolidated Mining Co.'s shaft at Homansville, Tintic district, Utah.

In 31 days the shaft was sunk a total distance of 261 feet.

The shaft consists of three compartments. The two hoisting compartments being 4 ft. 2 in. square inside measurements, and the third, or man-way, compartment 4 ft. 2 in. by 3 ft. 2 in. Timber used consisted of 8 by 8 in. for the sets and 2 by 12 lagging for the outside lining. The sets were spaced 6 ft. apart.

The rock was limestone lying in flat beds, some of which were quite hard and some soft.

The shaft was operated in three shifts of four machine-men each and a topman and engineer on each shift. On day-shift two timbermen did the timbering.

The Sullivan and Denver rock-drill sinking-machines were used. Two five-foot rounds of about 22 holes each were drilled per day.

The timbermen worked on what was termed a 'suspended bulkhead and shooting set,' consisting of a set of 8 by 8 in. timbers, the same size as the shaft sets, with $\frac{1}{4}$ in. sheet iron plates bolted on the bottom of the two outside compartments. This device was suspended on both ends by means of one-ton chain-blocks hung from two sets above, allowing the bulkhead to be lowered a sufficient distance from the bottom set to allow a new set of timbers to be put in place, without stopping the work of the machine-men and shovellers below. This arrangement added greatly to the safety and speed of sinking.

Hoisting was done through the centre compartment only, by means of two 15½-in. ft. buckets used alternately a chain hung from the head-frame. This chain was hooked into a ring on the bottom of the bucket, holding the bottom stationary and allowing it to tip on an incline door and chute, thereby discharging its contents.

Walter Fitch, Jr., was manager; J. D. Matheson, superintendent; and J. H. Santo, foreman.

Flotation

A Discussion Before the American Institute of Mining Engineers at Globe, Arizona, on September 21, 1916

THE CHAIRMAN (C. E. Mills): Gentlemen, the subject of this afternoon's session will be 'Flotation.' The first item on the program will be an abstract of Mr. Cole's paper, 'The Advent of Flotation in the Clifton-Morenci District, Arizona.'*

DAVID COLE: There is much kaolinized material in Morenci ores and a great deal of colloidal matter is developed in milling them. The Elmore process had been tried by the Detroit Copper Mining Co. some years before and had been defeated, it was reported, by the slime. This delayed the serious consideration of the flotation process in the district. After it was found that flotation would apply at Morenci, there were difficulties to overcome on account of the restriction of space in the mill-building, known as concentrator No. 6, of the Arizona Copper Company.

Morenci ores are heavy in sulphide minerals and have relatively low ratios of concentration—from 7 to 9 into 1. It is therefore economical to remove a large portion of the copper sulphides in primary roughing operations. After the removal of the easily separated coarser sulphide minerals, there remains a matrix similar to the disseminated 'porphyry' ores, requiring fine grinding to release the remaining sulphides. The grade of the material that reaches the re-grinding departments in Morenci practice is similar to that of the mill-feed of the 'porphyries,' and the process required below the roughing-out stage is substantially the same as that required in the large plants handling finely disseminated copper ores.

The re-grinding equipment adopted at the No. 6 concentrator of the Arizona Copper Co. consisted of twelve 8 by 3-ft. Hardinge mills. These used pebbles for both lining and grinding media, and occupied all the space available. The capacity of these mills for finished work was therefore the limiting feature as far as plant-capacity was concerned, and if the re-ground product was to be so limited in size by the degree of grinding required by the flotation machines then available, namely, to pass a 48-mesh screen, the capacity of the plant would be greatly reduced.

Therefore, when flotation was found to be amenable, it became desirable to develop a flotation machine that would not be clogged or embarrassed by the accumulation of oversize; that would afford a standard and completely effective treatment to the sizes in the re-ground product coming within the range of flotation; and a machine that would not be embarrassed by sizes too coarse for recovery in the froth. It was at once realized that on account of the complete removal of the slimed sul-

phides in the frothing operation, the pulp so treated would have been classified in a most desirable way to make the recovery of the remaining free sulphides relatively easy and complete.

In order to do this in the limited space afforded, the C-B flotation machine, described in my paper, was designed, constructed, and operated with the results given. Mr. Julius Bergman, working with me as mechanical engineer, assisted greatly in the detail work and development of the machine, and it was therefore christened the Cole-Bergman Frothing Classifier.

The spitzkasten type of machine, which is also illustrated and briefly described, has not as yet had a trial, but I have much confidence in its usefulness in certain situations. It differs from the C-B or stepped type, as those who have read the paper will note, by including in the flotation treatment or frothing operation the usual features of spitzkasten sizing.

With this piece of apparatus the ore will be taken direct from the ball-mill where it has been ground in the presence of the frothing reagents, and we hope and expect to get a good froth-concentrate over the top as usual, together with a coarse classification of the sand in the hopper of the spitzkasten nearest the intake of feed, and successively finer sand (within reasonable limits, of course) in the hopper following toward the discharge. The overflow rejected from the first of these machines will contain nothing too large for flotation; it can be re-treated and discharged to tailing, while the sand drawn from the hopper will be in good condition to make feed for the tables, which will readily remove the sulphide particles too large either to go over with the primary froth or to remain in suspension long enough to escape with the overflow, and thus receive another frothing treatment. The sand from the first frother after the table treatment can be returned to the grinding-mill for further reduction and complete re-treatment, or be discharged as waste, thus making a simple 'frothing first' flow-sheet.

I receive a good many inquiries from people who have heard of the C-B scheme of treatment, asking for laboratory sizes of the apparatus on which to test their ores, thus implying that there must be something about this method of treatment that will result in higher recovery than by the use of other types of apparatus. I can see no advantage in using small or laboratory sizes of the pneumatic types of flotation machines and have not made any attempt to provide a bench-size machine, and would not recommend it.

In testing ores by flotation in a laboratory it is necessary to have a good mixer as well as a good frother, and

*M. & S. P., October 14, 1916.

when the two can be combined as in the mechanical or impeller type (all of which seem to be a modification of the Hoover idea) this is the logical machine to use in the bench-work stage of the investigation. If good results are obtained with the impeller type in the laboratory, it is practically certain that better results can be obtained in the full-size unit in the mill, either with the impeller type or the less expensive pneumatic type, one of which I have attempted to describe in my paper.

RUDOLF GAHL. Since I wrote the paper on flotation† that is in your hands, important developments have taken place, and for this reason I shall try to bring it nearer to date by a few remarks.

You will have noticed that at the Inspiration concentrator, flotation is not entirely relied upon for the recovery of the coarser mineral particles, but that the flotation tailing is split on drag-belts into a sand and into a slime, the sand product being re-treated on tables. We have found that if we wanted to, we could leave out these tables and substitute flotation machines, as flotation machines will effect fully as good, if not a better, recovery on such deslimed material as tables, but a treatment of this kind would be more expensive in view of the fact that oils are required costing more than the oils that we are using now in our main flotation plant. For this reason, we are not considering making such a change. We have decided, however, to install flotation machines for the treatment of our table-middling, as on the middling product, which is of a somewhat higher grade than our present table-feed, a more expensive treatment seems justified.

I would also like to add a few remarks regarding the treatment of oxidized copper ore: Although our experience shows that hydrogen sulphide and other soluble sulphides will facilitate a good recovery of the copper carbonates in certain ores, we have not been able to prove that it would be advisable to adopt such a treatment for the ore mixture that is sent to our concentrator now, and have, therefore, looked toward leaching for recovering the oxidized copper now being lost.

It may interest you to hear that we figure on using limestone for the precipitation of the copper that will go into solutions. Small-scale experiments in this direction showed encouraging results. If the limestone precipitation will do what it seems to promise, it may develop into a novel feature of copper metallurgy.

FREDERICK LAYSE: The relative merits of the impeller and pneumatic types of flotation machines have been the subject of much discussion and the selection of type is doubtless dependent largely on local conditions and on the characteristics of the ore undergoing treatment. We have always been of the opinion at Anaconda that whenever a neutral or alkaline treatment was used and the oils could be added to the pulp going to the ball mills, the pneumatic type had an advantage both as regards power-consumption and installation cost. When, however, the treatment required the use of acid, as is the case on some copper ores and most zinc ores, the pneu-

matic machine loses much of its advantage. Obviously, the acid cannot be introduced into the ball-mill and it is generally necessary to add it ahead of, or at the same time as, the oil.

Thus it becomes necessary to insert an agitator between the ball-mill and the flotation-machine, the pneumatic treatment alone not being sufficiently vigorous. The early pneumatic-machine installations contained Pacheca tanks for this purpose. These, however, did not prove effective, for the reason that an emulsification of the oil is required and not merely agitation. It therefore becomes necessary to use an impeller or some form of mechanical emulsifier, and the power required to operate this machine must be added to the power consumed by the flotation-machines proper.

In Montana we find that our power consumption for emulsifying and flotation is about 0.24 hp. per ton as compared with 0.15 hp. for flotation alone at Inspiration. The capacity of an impeller machine is materially greater when the emulsification of the oil in the pulp is done in the ball-mill. In this connection an interesting suggestion was recently made by Dr. Cottrell. He suggests making an emulsion of oil and water in a special emulsifier, such as made by the De Laval people, consisting of two discs running almost in contact. The oil and water is fed at the centre and is thrown out at the circumference. Thus the work of spreading the oil through the pulp might be done more efficiently than is now the case.

For some time it seemed to us that the main point to be considered in choosing between the two types of machines was power and that this depended largely upon whether acid, neutral, or alkaline treatment were selected. Of late, however, it has seemed to us that the impeller type of machine has another advantage, which, I recall quite distinctly, was cited as a disadvantage when the first Callow machines were brought out. I refer to the toughness of the froth. Most of you doubtless recollect that one of the advantages of the pneumatic machines was supposed to be that the froth breaks down quite readily, thus rendering the mineral content of the froth easier of collection. It is becoming more evident to us, however, that this apparent advantage is actually the reverse, for the reason that the coarser mineral grains tend to fall back before they can be skimmed off and thus are lost or must be recovered by tabling. We are beginning to believe that the tougher froth is a distinct advantage of the impeller machine and our belief has been considerably strengthened lately by tests made on a disseminated copper ore from South America. It was impossible to make as lean a tailing on the pneumatic machine as on the impeller machines, owing to falling back of the coarser mineral grains.

FRANCIS S. SCHMERKA: Regarding the proposed scheme of Dr. Gahl's for precipitating the copper solution, I desire to call attention to the fact that the sulphate of lime precipitated from the solutions would lead to the necessity for smelting in the blast-furnace. Naturally, from the sulphate of lime, sulphides would be

formed. Now, I thought that Dr. Gahl by thickening the pulp would assist the leaching.

RUDOLF GAHL: I believe fully everything that Mr. Laist says, except his conclusions. His remarks regarding the relative hardness of the froth produced by the different types of flotation machines suggests that it might be worth while trying to modify the froth by reducing the air supply, and perhaps also by reducing the froth in the flotation mixture. I feel sure that the character of the froth can be modified to some extent, although I doubt very much if it ever would approximate the froth in the standard type of machine. Regarding Mr. Schimerka's remarks, I would like to say that I know little about smelting, and have not considered the smelting problem carefully. All I know is that Mr. Wallace, who used to be smelter superintendent of the International, assured me that he could smelt that stuff, and could pay for the lime also. Regarding the other point Mr. Schimerka brought out, about adding the acid to a thickened pulp, my impression is this, that a still larger part of the water-supply would be contaminated because we have to figure mainly on leaching very fine slime containing oxidized copper; and it is the experience of every mill-man that to settle this slime to any consistence it must exceed 3:1, that is, three parts of water to one part of solid. That would mean, if he added the acid to the thickened pulp, we would spoil three tons of water to each ton of leached ore.

DAVID COLE: Mr. Chairman, I understand that Dr. Ricketts 'turned down' Dr. Morse when advocating leaching processes for low-grade tailing by methods that involved first getting the copper into solution and then separating the solution from the pulp in a clarified condition, which is difficult and involves much washing with clear water, etc., resulting in thin solutions, the latter entailing 'miseries' in effecting precipitation and recovery of the metal. On the other hand, Dr. Ricketts approves the present process which Dr. Morse is using at Chino, in which the oxidized copper is first taken into solution by the use of about three pounds of sulphuric acid per pound of copper digested; this copper is then precipitated upon the iron in an agitated mass, which results in metallizing the copper at the expense of about two pounds of iron per pound of copper precipitated. The metallized copper is then in a fine state of division in the pulp, and the remaining copper sulphides that were not attacked by the acid are also in the pulp in a fine state, and the whole is subjected to flotation treatment for the removal of both the sulphide and metallized contents, thus doing away with the necessity for removing the solution in a clarified condition from the pulp under treatment, avoiding the washing of the pulp for complete removal of solutions pregnant with copper, and avoiding most of the 'miseries' previously unavoidable.

Miami has been experimenting for some time along the same line and has achieved success on a laboratory scale. Flotation has been used successfully in the separation of ultra-fine native copper in Michigan, and

there seems to be much promise in this new scheme of treatment for the recovery of copper in low-grade ores when in a mixed condition of oxide and sulphide.

I have read with very great interest Dr. Gahl's painstaking paper giving us the details of development of flotation at Inspiration. Prior to the use of flotation in concentration it had long been recognized that the 'unavoidable' loss of sulphide was in the slime inevitably produced in the grinding operations required to free the minerals. The classification of the feed prior to the final stage of treatment had long been in fashion, it assisted the sand-treatment machines and resulted in lowering the tailings made by them, but at the expense of the slime-treatment department; and while little was ever expected of the latter, the wisdom of complicating the process by hydraulic subdivisions was being seriously questioned. Indeed, at the time that gravity-method flow-sheets were being developed for Inspiration ore, there was a minor revolution impending through the improvement in table-practice and the elimination of the hydraulic classifier. This return to simplicity gave no promise of higher extraction, but it did promise a less complicated mill, smaller in size per unit of capacity, less costly to build and less expensive to operate, and that would do as well. Wholesale concentration in relatively small space would get as good results as piecemeal concentration had been getting in the multiple operations and spread-out plants of the disseminated copper mines.

The one great drawback was the slime. The desiderata of the engineer and manufacturer were to provide a grinder that would on one hand produce a minimum of slime, and improved devices on the other hand to recover as much as possible out of what was unavoidably made. The technical press reflected this state of things in the advertisements of the period. There was much revamping of old ideas with some refinement, but nothing new. Tube-mill grinders were taboo for concentration, because they had a bad reputation as slime-makers. Automatic canvas plants were being exploited and very ingenious multiple-deck table-devices were being offered as the "remedy"—the only one in sight.

Looking backward no farther than 1912, when the Inspiration was devising its milling methods, we now see that we were without effective resources in combating real slime. Mr. Callow's investigations[‡] apparently had demonstrated that some departure from the usual gravity practice would be advantageous and that a high recovery for that method would be possible on the granular material. There was nothing new to apply to the slime itself, and we now see that the departures were really of minor importance, fitting the time. This was the situation when the Inspiration company was endeavoring to evolve a scheme of milling.

After reviewing from every angle the results of experiments on the ore and other information available, a modified flow-sheet was finally crystallized by Mr. Burch and adopted by the management. Mill-plans were drawn for what was to be a most highly developed 7000-ton per

[‡]M. & S. P., May 29, 1915.

day gravity-process plant, and work was immediately started to carry out these plans. The mill-site was selected, and much active work had been done before flotation (by this time being hastily tried in the old experimental plant) had so far won its battle that results could be viewed as hopeful.

The apparent promise of flotation, however, was extremely attractive, because the process would be simple and would solve the all-important slime problem. The process would have a greatly reduced number of stages! The plant would be much smaller per unit of capacity! The cost of construction per unit of capacity would probably be very much less! The use of water would be minimized. Grinding would have to be carried farther than usual, and would be the main item of milling cost, but this was not a very great handicap because slining did not matter! What system of grinding would be best to use and which the best machine? Would it be possible to parallel the small test-mill results on a full tonnage, and finally would it not be too hazardous to accept so revolutionary a process with so many untried features?

The mine would produce about 600 tons daily of freshly broken ore directly from the headings. This happened to be the rated capacity of the full-sized Minerals Separation unit that the flotation people were urging as a means of improving their extraction. If this ore from the headings were put in stock pile in the usual way, pending the completion of the plant, the ore would oxidize to some extent and besides would involve reclaiming expense later on. Why not mill it as fast as produced, in an experimental mill, wherein not only flotation problems, but grinding problems, power consumption, use of water, preparation of sticky concentrates, and other vital questions could be definitely threshed out under what would be regular commercial conditions on full-sized machines! Thus these 'pilot' operations labor would be used economically, and production would almost, if not quite, pay all of the current expenses, except the mining cost.

This program was adopted. That the decision to carry it out was a wise one is shown in Dr. Gahl's and Mr. Burch's admirable papers, and that it paid its way is shown by Mr. Mills's annual report for 1915, in which he says: "Contrary to the usual experience, this test-mill paid the cost of its construction, its operation expense, the present average mining cost on ores treated, and something besides, and has been written off the books."

Thousands of dollars were spent by the company, by inventors, and by manufacturers in demonstrations. Expense was subordinated. Heavy shipments by express were made when necessary to hasten the work, and much more than flotation was developed.

Four different types of Symons crushers and pulverizers were tried. Three of these were marked and interesting departures from ordinary practice. The company had purchased the Hardinge patent rights for Arizona and four forms of this mill were installed to de-

termine the best form to use, and these were kept busy during nearly the whole campaign. A long parallel tube-mill was installed and run in competition with the Hardinge mills. A high speed Huntington type grinder was at one time a prime favorite. Hammer-pulverizers of two different makes were centres of interest for brief periods. Various linings and grades of flint were tried in the pebble-mills. Steel balls in place of pebbles were advocated and a carload purchased.

In the latter part of the testing period the Marcy type of ball-mill, especially designed for using iron balls larger than usual, and adapted to crush from breaker size to 48-mesh in closed circuit in one operation, was installed and perfected. This grinder proved capable of a greater range of reduction than had previously been thought possible, taking feed as coarse as 3-inch cubes. It is a ball mill pure and simple, having large capacity in small space. It makes use of a perforated diaphragm to keep the balls and charge inside of the mill until the latter will pass a $\frac{3}{8}$ -in. opening, and it has the equivalent of a peripheral discharge. An overflow-classifier determines the finished size and the oversize is continually returned to the grinding-chamber. This mill uses little water in the grinding-chamber, so that its charge of ore is mortar-like in consistence. It was quite successful. There was nothing in the Hardinge equipment to parallel it because the Hardinge mills were built for pebble-mills and did not have feed-scoops or openings adapted to handle as coarse a feed, and the linings would not stand up under a ball load. Would the Hardinge machines when built as a ball-mill with the required strength, with the same type of lining, same size of feed and discharge openings, do as well? To wait for a mill to be made over or a new one manufactured would take too long, so the Marcy type was adopted, and contrary to what I think is the popular impression, the conical type ball-mill did receive a trial at the Inspiration.

Electric recording instruments were installed in the test plant so that accurate power-records could be continually made while the various machines were being operated.

Several varieties of drag and rake classifiers and two types of vacuum filters were installed and records made. The efficiency of high reduction herringbone gears for driving ball and tube mills became a matter of interest on account of the troubles that developed in them, and the reasons for these troubles, which would make a paper by itself.

This testing work grew into a process of elimination; the scrap pile grew steadily; much of it is yet to be seen at a point below the present concentrator. Some blasted hopes may be buried there, but it does not follow that all of the machines or materials that were returned to the sponsor or that found their way to the 'bone-yard' were entirely unfit. It was necessary to choose and to discard and that there is no acrimony in connection with the matter speaks well for the justice and judgment that prevailed. Doubtless some discarded things might have

answered as well, but it would be hazardous indeed to say that anything vital on the score of cost or recovery failed to receive recognition in the final selection. One of my mental offspring was among the fallen. It held out for a long time and I greatly appreciate the favorable mention which Dr. Gahl has made of it.

Referring to the flow-sheet finally adopted, I note that hydraulic classification had no place in the 600-ton experiments that Dr. Gahl has described, and I note that he has not referred to the reason for retaining this remnant of the old system of concentration in the flow-sheet. You will observe that three tons of water per ton of ore is required in the flotation operation and that three tons more is added in the subsequent table-treatment. This, of course, includes the hydraulic classification, and I presume that something more than one-half of the last three tons is added in the classifiers themselves; and since the water is clarified and returned, the addition of unnecessary water would entail expense for clarification and pumping.

In my work in the concentration of ores I have not been able to become enthusiastic over hydraulic classifiers, and since flotation has come to the rescue of the slimed sulphide I find myself less enthusiastic than ever over their use. When I was a lad in the Black Hills I used to watch a mountain spring in which polished micaceous particles glistening in the sunlight would be caught in the current rising from an orifice in the bottom of the sand-funnel and be flirled to the surface, sail across the crater and fall upon the conical sides, to be methodically returned over the same route again. It was interesting to watch the disturbance caused by dropping a handful of foreign sand and silt into the funnel and have it 'classified' and washed clean, a new form of crater finally being established with the changes of average sizes retained. My first contact with hydraulic sizing in concentration was studied from that foundation. The spring took its time to do a good job! It worked the charge over repeatedly! All the silt went out quickly and the fine gradually went overboard with a rapidly decreasing ratio, until the crater would settle down again to its regular work of turning the mobile contents over and over in a new condition of equilibrium. But I soon learned that the beauty was all taken out of the process in its commercial application.

The process witnessed in the action of the spring was balanced, precise, and definite, and quite at variance with what we witness in watching through glass the operations going on in a teeter-chamber of the metallurgical hydraulic classifier, which seems to me to be of little value except in its office of washing out the slime that used to be the main source of the loss in treating unclassified material upon concentrating tables.

Following the thorough 'combing out' of the slimed sulphide as effected by the splendid flotation treatment that the pulp has previously received, I question the value of the subsequent classification by hydraulic means. I note that the flotation tailing is split into slime and sand at the drag-belts, that there is very little slime left

in the sand portion, and that what little there is (on account of the previous frothing) is completely devoid of anything the tables can save, as indicated by the fact that the main slime overflow of the drag-belt separators is discharged to tailing without further treatment. It seems to me that it ought to be possible to eliminate the classifiers, and I would like to ask Dr. Gahl if there has been any trial to determine what happens when the previously frothed sand-feed is put upon the tables for final treatment without hydraulic-sizing separation.

R. S. HANDY: I would like to ask if anyone has determined the relative economic efficiency of flotation as compared with gravity treatment on granular material.

E. P. MATHEWSON: It is the practice in Montana to take everything that is possible by means of tables or other water concentration machine; and at the Anaconda plant we take out a concentrate of 1½-inch, and keep on taking out finer and finer material by water concentration until we get to the tables. What is left from the tables and not saved is then ground up and put through the flotation. We find by our experiments that it is better to keep the slime separated from the feed, and we give them a little special treatment as regards sand.

DAVID COLE: I consider it unnecessary to first remove the slime, for the reason that after the slime has been subjected to flotation treatment there is nothing in it that a table treatment can save, no sulphides in a sufficiently fine state of division to be transported by the slime, because the previous frothing operation has removed it all, and when the slime is 'denatured' in this manner it is no longer harmful upon the table, and does not interfere with the working of the sand upon the table. The table will do exactly the same work upon the sand that it would do if the slime were not going across and off, in the rear of the sand, with the excess water. If no previous division or washing-out of slime is practised we have gained to the extent of the trouble and cost that would be entailed in making the division. That is the way I view the matter.

L. D. RICKETTS: I think it has been brought out that the ratio of concentration has something to do with the process of ore treatment. In other words, at Anaconda, where they have a low percentage of gravity concentration, flotation is applied only to the final cleaning up process. At Inspiration, flotation is the primary process, and gravity concentration is put in as a safety to prevent loss of coarse material, the reason being that in one case you have a low ratio of concentration and in the other a high ratio of concentration. When you come to ores with a moderate ratio of concentration, I think the balance would be in favor of getting as much gravity concentration as possible. So, I would say, in a great many of our plants with a great many of our ores, even where the ratio of concentration is only ten or twelve to one, it is profitable to have gravity concentration first, followed by flotation.

DAVID COLE: I have noted Mr. Mathewson's remarks concerning the Anaconda practice. Apparently he is under the impression that they really are desliming the

feed before treatment on tables. The Anaconda flow-sheet shows such a separation and the Anaconda type of conical deslimer is installed with that end in view, but like Mr. Mills's admission as to Inspiration's poor classification practice, Anaconda doesn't do good classification. The feed to the tables is not deslimed as it was intended it should be, the reason being that there are not enough of the Anaconda classifiers to do the work put upon them, and since the only office of these classifiers is to prepare feed for the Butchart riffle treatment, and since these tables have no office but to impoverish the ore treated by them, the complete separation of the slime from the feed is of little consequence, for all reject from the tables is taken at once to the re-grinding mills where the cleaning-up work is most thoroughly accomplished by the flotation process. If the tables were making a reject to tailing, the Anaconda classifiers would have to do their full duty in desliming the feed to them, because the slime going across the Butchart tables would result in serious losses, but since it is immaterial whether the primarily made slime reaches flotation treatment over the top of the classifiers or through the spigot, the classifier's inefficiency and the results as to the reject from the tables are tolerable and there does not seem to be any reason to change. Obviously, it does not matter at Anaconda where the copper is taken out so long as a minimum amount of it is allowed to get away with the final tailing, and it is also obvious that with Anaconda's present practice, wherein the ore is reduced by their splendid treatment scheme from a 60-lb. copper content to less than a 3-lb. copper tailing on a ratio of practically three into one, the chance for improvement in practice through modification or more perfect slime classification is extremely remote.

E. P. MATTHEWSON: I would like to make a correction in one statement I made that there has been no change made in our oil mixture at Anaconda. This change has been made: We found that the amount of wood creosote in treating the sand tailing was extremely small, and we tried some experiments on a large scale, dropping it out and using simply the sludge acid and sulphuric acid. We found that this gave practically as good results as wood-creosote. We use wood-creosote in treating slime. We find it necessary in that operation.

DAVID COLE: What is sludge acid?

MR. MATTHEWSON: Sludge acid is refuse from the refining of oil. It contains sulphuric acid and some greasy material from petroleum.

DAVID COLE: I believe that you are making sulphuric acid very cheaply at Anaconda. Since sludge acid consists of coal oil and sulphuric acid, I have wondered if you could not compound it at Anaconda more cheaply than you can buy it.

E. P. MATTHEWSON: We have made sludge acid at Anaconda, but it is more expensive than we can buy it outside. We got good results with the acid we manufactured.

NOELMA CARMICHAEL: One point which has not been touched on in this discussion today. In going through

the Old Dominion concentrator before luncheon, I noticed that they were using what appeared to be caustic soda. I think if there is anyone here who can give us any explanation in regard to the use of the caustic soda, it would be interesting.

W. B. KRAMER: We find, as Dr. Gahl finds, that the moment we use acid in flotation, our flotation suffers considerably. In fact, it almost ceases altogether. It is improved by the use of caustic soda. Caustic soda is expensive, and we are using about one pound to a ton. Soda has the effect of flattening the froth considerably, allowing us to cut down the water in the launders to less than half, which allows us to handle the concentrate in the Dorr thickener very well. Without the use of caustic soda, we may lose four or five tons of concentrate per day. It goes out and is recovered later in the secondary tanks.

C. W. MERRILL: I understand that the purpose of using caustic soda is threefold; to cut down the water, increase the extraction, and clean the concentrate.

DAVID COLE: Mr. Chairman, when we were at Chino a few days ago, we saw flotation-machines treating vanner-concentrate by aid of alkali and resin as the flotation agent. Mr. Ralston looked at this, and I would like to have him tell us what we saw.

O. C. RALSTON: That was a solution of sodium resin-ate. The resin has a good effect on the froth, making it particularly stable. They were working under conditions where the froth wanted to die, and the addition of the resin was the proper thing to bring up its strength and allow it to rise until it passed over the discharge-board. I think there was no significance in the alkali. In that case the alkali was not added for a particular purpose, but simply as a solvent for the resin.

THE CHAIRMAN: I understand that Mr. Ralston wishes to get some questions answered by the members of the Institute, and I will ask him to kindly present those questions.

O. C. RALSTON: The first one is this: What is the effect of dilution of pulp with water on the flotation of the minerals contained? The reason for asking that question is obvious. I think Dr. Gahl might help us.

REDOUF GAHL: I would say offhand that the effect of dilution is to make a cleaner concentrate, and make it more difficult to produce concentrate, because I think you would find that it would take more to produce the same amount of concentrate from a dilute part than from a stronger part.

O. C. RALSTON: Might I supplement by asking you what determines the amount of oil necessary for flotation. Is it the amount of water you are using, or is it the amount of mineral in the ore? If you had an ore consisting of 50% mineral, could you use more oil then if it contained 5%? What amount of oil must be used in flotation?

REDOUF GAHL: What is flotation? I don't feel like answering Mr. Ralston.

O. C. RALSTON: The Superior ore, containing 30% of oil, as compared with the Inspiration ore with

5 or 10% of mineral, uses probably less oil, if anything. So, the proposition would be that the amount of mineral in the ore is not determinative of the amount of oil necessary. It must be the amount of water that determines the amount of oil.

DAVID COLE: I think the kind of oil has a lot to do with the amount used.

O. C. RALSTON: That is a question not of theory but of experience. For instance, the pine-oils are being used in the Coeur d'Alene district at less than $\frac{1}{2}$ pound to the ton, while at Anaconda they use several pounds of oil per ton. At Anaconda they use a considerably less expensive oil.

DAVID COLE: Speaking of the small amounts of oil, we carried out some experiments the other day at El Paso, and on a density of 7:1, approximately, on an ore that contained 6% lead, 9% zinc, and 1.3% copper, with the use of $\frac{2}{10}$ pound of cresylic acid per ton, we were able to take out a large percentage of the lead. Then, by the addition of $\frac{3}{10}$ pound of No. 350 pine-oil per ton, we were able to take out the remaining zinc. The products assayed as follows:

	Weight	Gold	Silver	Lead	Cop- per	Iron	Zinc
	%	oz.	oz.	%	%	%	%
Lead concentrate	12.86	0.11	12.85	35.7	7.32	7.7	13.0
Zinc concentrate	25.08	0.025	2.67	4.4	1.30	3.9	23.6
Tailing	59.68	0.005	0.45	0.3	tr	3.0	1.9

This was done in a single operation without the use of a 'cleaner' on the concentrate. There was very little oil used—a total of $\frac{1}{2}$ pound per ton of ore. If we had used a larger amount of oil, we would not have been able to get the separation. We put in just enough cresylic acid primarily to get that result.

THE CHAIRMAN: I think Mr. Gottsberger might contribute something. The fact is that the Miami Company and the Inspiration Company are treating similar ores, except we, at the Chino, have not as much copper as they have. We use quite a little more oil in flotation than Mr. Gottsberger does; and I think, perhaps, they have got more water in the pulp. Is that about the condition, Mr. Gottsberger?

B. B. GOTTSBERGER: Our oil-mixture is much thinner because we are using less coal-tar. I think we have found that with a thick mixture composed very largely of coal-tar it is really necessary to add the oil in the grinding-mill. We do find, however, that it is not essential to add these oils in the grinding-mill in order to get good flotation work. At present the mixture is obtained in a bucket-elevator.

THE CHAIRMAN: Can you give us another question, Mr. Ralston?

O. C. RALSTON: Are ores that contain much fine material harder to treat successfully than granular ores? As far as I know, they usually are.

RUDOLF GAILL: That is my impression also.

O. C. RALSTON: There is another question in my mind. Is it possible to treat colloidal material? Would it be possible to deflocculate and separate the granular material?

F. S. SCHMERKA: Has it ever been noticed by the flotation experts present whether it makes a difference as to what density the pulp is when the oil is added in the grinder or mixing machine—whether a pound of oil goes farther at a high density?

Concentration at Miami

MILL STATISTICS, JANUARY TO JUNE, 1916

Dry tons milled	859,485
Tons per day	4,722
	%
Copper in feed, total	2.09
" " " oxidized	0.32
" " " sulphide	1.77
" " concentrate	41.74
Insolubles in concentrate	22.10
Copper in tailing, total	0.56
" " " oxidized	0.30
" " " sulphide	0.26
" recovered	74.06
Material in tailing, -48 mesh	12.53
Power, kw.-hr. per ton milled	12.97
Total men per day	208.76
Tons per man per day	22.62
Fresh water per ton of ore, gal.	321

MILL POWER-CONSUMPTION, JUNE 1916

	Kw.-hr. per ton
Crushing and grinding	7.86
Concentration	1.84
Reclaimed water	1.39
Miscellaneous	0.36
Total	11.36

WATER USED, JUNE 1916

	Gal. per min.	Gal. per ton
Total flow in mill	5471	1428
Fresh water	1273	332
Reclaimed water	4198	1096
Water reclaimed	76.8%	
Ratio, solid to water, total	1:5.95	

FLOTATION MILL

	%
Copper in the feed	1.95 (oxidized 0.5%)
Average copper in the tailing	0.60
Average oxidized copper in the tailing	0.45
Aerating and elevating, kw.-hr. per ton	2.95

Mixing is done by launders and elevator.

The oil is not mixed in the grinding-mills.

Fifty-hp. motors on blowers, 45 hp. used; 8 Callow roughers and 2 Callow cleaners per section.

Capacity, 75 tons per rougher cell.

EXPERIMENTAL PLANT

6 ft. by 22 in. Hardinge mill.

2-in. steel balls with 20 each of 4-in. balls.

One 6-ft. Dorr classifier, returning oversize.

Crushing from screen analyses to 1% on 48-mesh at rate of 115 tons per 24 hours.

Power used, including coarse crushing, 8.56 kw.-hr.

Density of overflow from classifier, 1:2.

Circulating load 500 tons sand returned, making 600 tons total load.

85% of concentrate made in plant will pass 200-mesh.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

Acid is not used in flotation of Mount Morgan gold-copper ore.

SINCE GOLD-DREDGING operations commenced in California in 1898 until the end of 1915, the total output of gold from that source has been \$79,104,231.

OF THE PLACER GOLD produced in California in 1915, the dredges produced 90.5%, the hydraulic mines 5.0%, the drift mines 3.1%, and the surface or sluicing mines 1.4%.

TIMBER lasts longer and requires less replacement in a down-cast than in an up-cast shaft. In the latter the hot gaseous air from the mine tends to accelerate the decay of the timbers.

CADMIUM is not desired in zinc used in alloys as it makes them hard and brittle. For galvanizing wire spelter must be pure or the coating cracks and peels off under sharp bending in making splices.

OILS used in flotation at the Suan mill, Korea, consist of eucalyptus, 0.23 lb. per ton; pine-tar, 0.014 lb.; coal-tar, 0.115 lb.; No. 2 red oil, 0.173 lb.; and kerosene, 0.025 lb. Lime consumption was 2.8 lb. per ton.

EXCHANGE between New York and London is quoted at about \$4.75, that being the value of the English bank-note. But the 'sovereign,' which is the standard British gold coin of the value of £1, remains at \$4.8665, the price fixed by the United States government as measured in dollars.

COST OF POWER is usually given in cents per ton. This affords no basis of comparison. It should be stated in horsepower-years or kilowatt-hours. The actual cost of power as sold to the consumer is also a useful bit of supplementary information, when making any comparison of cost at mines or mills in widely separated localities.

MOUNT MORGAN ore consists of a mixture of iron pyrite, copper pyrite, and gold in a quartzose gangue. The smelting ore contains up to 50% silica, the concentrating ore 73%. The latter approximates 6% copper pyrite, 16% iron pyrite, and 78% quartz calcite. The gold is free but in a very fine state of subdivision.

Oil, used in flotation, especially in the treatment of copper ores, should be tested against a standard oil under standard conditions, and they should be purchased on results of testing and of fractional distillation, according to W. Shellshar in the June Bulletin of the Australasian I. M. E. Turpentine, which is not able to be distinguished from the first distillate of eucalyptus,

is too often used in large quantity as a diluent of eucalyptus.

THE THREE MOST IMPORTANT properties in rock used for constructing roads are hardness, or the resistance which the rock offers to the displacement of its surface particles by abrasion; toughness, or the resistance which it offers to fracture under impact; and binding power, or the ability which the dust from the rock possesses, or develops by contact with water, of binding the large rock fragments together.

DIAMONDS are valuable not only for personal adornment but find many varied uses in the arts and manufactures. Some of the more common uses are in glass-cutting, drilling and sawing blocks of hard stone, truving emery wheels, drilling in hard steel, and drawing wire for electric lamps. They are also employed in mining operations the principal of which is in deep borings. For this latter purpose amorphous diamonds, known as Brazilian carbons, are the most suitable.

CONCENTRATE produced at the Suan mine, Korea, in July, from 4350 tons of ore assaying \$9.85 gold and 0.91% copper, was as follows:

Class	Tons	Gold per ton	Copper %	Bismuth %	Gross value per ton
Regular	35.58	\$91.38	20.28	2.25	\$194
Canvas	1.33	140.65	9.44	2.86	212
Black	15.94	196.71	22.12	2.79	312
Flotation	83.93	28.07	28.08	2.06	156
Total	136.78	\$65.28	25.17	2.20	\$184

BLASTING BOULDERS is successfully done by block-holing, snake-holing, and mud-capping. In the first method a 1½-in. hole is drilled half through the rock, charged and exploded. In snake-holing a hole is punched down with a bar directly under but along side of the boulder. The hole must be deep enough to allow of the charge being placed under the heaviest part of the rock. Mud-capping is simple. Dynamite is laid on top of the rock, well covered with plastic mud only, 5 or 6 in. thick, and exploded. This system is not efficient if a boulder extends into the ground.

SONSTADT SOLUTION is prepared by taking a saturated solution of potassium iodide in water, and adding mercuric iodide until the required specific gravity of solution is obtained. At Mount Morgan this is used to determine whether gold occurs in quartz or pyrite. A minus 80 and plus 120-mesh sand was added to the Sonstadt solution and stirred well. To prevent its solidifying the solution was kept warm. The quartz floated on top of the solution, was skimmed off, filtered, and dried. The original sand assayed \$5.13 gold and 0.74% copper, the quartz product \$3.91 and 0.05% and the mineral product \$9.79 and 1.85%. This proved that a certain amount of the gold is associated with the quartz.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

FURTHER DRAINAGE NOTES.—PROBABLE LABOR TROUBLE.

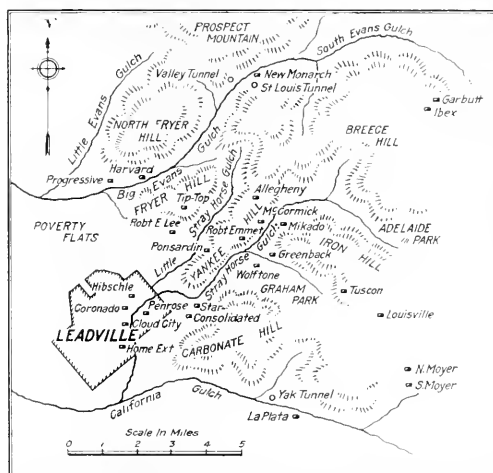
Drainage of the greater part of the productive area of the Leadville district is the one great factor holding promise of increased activity in the future. Within the year the United States Smelting, Refining & Exploration Co. has erected a costly modern plant and buildings at the Harvard and drained the Fryer Hill basin to a depth of 700 ft.; ex-governor Jesse F. McDonald has organized the Down Town Mines Co., installed expensive pumping machinery at the Penrose, and unwatered the Down Town basin to a depth of 900 ft.; the Empire Zinc Co. and the Western Mining Co. have installed new pumping equipment at the Wolfstone and Greenback properties at considerable cost, and are now draining the big Pyrenees basin to a depth of 1350 ft.; and George O. Argall, manager of the Iron Silver Mining Co., is now re-timbering the Mikado shaft on Iron hill and installing modern pumping and hoisting machinery, preparatory to assisting in the draining of the Pyrenees basin and surrounding territory; while W. E. Bowden is re-fitting the La Plata shaft in California gulch for the purpose of draining the Rock Hill basin to considerable depth.

It is conservatively estimated that the combined cost of these pumping projects will total \$1,500,000. Without these enterprises Leadville would hold little promise of unusual activity in the immediate future. The greater part of the territory has been fairly thoroughly developed above water-level throughout that part that has for years been known as the Leadville district, and any developments of importance would necessarily have to occur in new ground. However, with these huge draining projects in operation, the possibilities of the future are unlimited. On Fryer hill, where all of the past exploration has been confined to the first contact, there is an expansive field for work at greater depth. The U. S. S. R. & E. Co., under the name of the Leadville Unit, as the Harvard enterprise is known, is now ready to begin sinking this shaft an additional 300 ft. into the second contract. In the early days Fryer hill and its very rich orebodies found at the surface were famous, but contrary to expectation later developments have been confined to the upper formations instead of going deeper. The Harvard will cut the parting quartzite within the 300 ft. of proposed sinking, and it is thought that the formations underlying will be found fully as rich as those that were mined above. This enterprise is considered to be the one holding unusual opportunities for great success.

The Down Town Mines Co. has undertaken and completed the heaviest pumping project in the district through the Penrose shaft. The entire basin is now drained to the bottom of the Penrose shaft, 900 ft., and development of the territory has been undertaken through the Penrose and Hibschie shafts. Past operations in this extensive territory uncovered immense bodies of iron and manganese ores, with occasional rich shoots of silver and lead ores. No development has been done throughout the Down Town section since carbonate of zinc was found in the Penrose dump, showing conclusively that this ore exists in the property. Zinc is undoubtedly the incentive for the unwatering of the Down Town basin, and the high spelter market tends to make the enterprise more promising. It is stated that the largest zinc lode in the district will be found in the Penrose, extending from the Bon Air to the south. Should this be found correct, and the market continues strong,

the Down Town company will be second to none in importance to the future of the district.

The parting quartzite has yet to be pierced in the Down Town section as in Fryer hill. Numerous faults have made several hundred feet difference in the depth of quartzite, it being much deeper in the Down Town area. Whether or not the work in the Penrose will be continued to great depth remains to be seen, but there apparently is a vast territory in this ground waiting to be opened. From the Penrose, north-west through the city and into the flats, little work has been done. A drill-hole was put down near the city limits several years ago, but was abandoned owing to trouble which arose



LEADVILLE DISTRICT, SHOWING POSITIONS OF PUMPING SCHEMES.

over titles to the ground, leaving no information as to what was discovered.

The undertaking of the Empire Zinc Co. and Western Mining companies for the draining of the Pyrenees basin through the Wolfstone and Greenback properties is an important one, because the area affected has long been one of the heaviest productive centres of the district. Several properties in this territory have been successfully developed at a depth of 1200 ft. The recent purchase of the holdings of the Small Hopes-Boreel Mining Co., adjoining the Wolfstone and Greenback, by the Empire Zinc, is one of the chief reasons for draining this area. The largest and most valuable body of lead-zinc ore that has yet been opened here has been uncovered in the Robert Emmet, one of the mines in the group. This ore-shoot persists below water-level, and is to be extensively developed following the unwatering. The Wolfstone and Greenback also hold possibilities for deeper development. It is reported that before the present drainage scheme is completed, the Wolfstone shaft will be sunk several hundred feet. Large deposits of copper ore at great depth are looked upon as a certainty in this ground. Most of the ore that has been mined has carried a high copper-content.

The Mikado scheme, under the management of George Argall, is probably the largest here. The preparations that have been made at the Mikado shaft mark it as one requiring the expenditure of much capital, justifying large returns. The ground to be developed has produced heavily in the past, and in on the trend of the large ore-shoots developed in the Green-back, R. A. M., and adjoining properties. The success of the undertaking is already considered assured, although now only in the first stage of preparation.

The La Plata project is far from the other drainage companies, but in a locality that promises unusual results. Carbonate of zinc is again the incentive here.

The result of the entrance of these live draining enterprises into the district is a revived Leadville. They have already given employment to several hundred men, and it is conservatively estimated that another thousand will be put to work following the completion of pumping. This means a bigger production, a bigger pay-roll, and better business and living conditions. The city has undergone a remarkable change during the summer. Carpenters and painters have had a busy season repairing all the old vacant houses that have come into demand. Real-estate men state that there is not an empty house in the city that is habitable, while a year ago there were scores to be had at low rents. Leadville is now looking forward to the best years in its remarkable history.

The labor question is again assuming a threatening aspect, due to the activity of the miners' union. Letters have been sent to the operators asking that they recognize the union, and a campaign has been started to organize the miners. A new scale of wages is to be demanded, it is reported, calling for \$3.75 to \$4.25 for 8 hours' work. It is generally considered that this is an inopportune time for demanding higher wages, because several large and important companies have just entered the district and are still engaged in draining and developing their holdings at their own expense, no ore being produced at this time. Furthermore, these companies have spent \$1,500,000. A demand for higher wages would, it is believed, cause these enterprises to shut-down. The labor question in Leadville always has been and always will be a problem. In many mining districts where one metal is mined, as in the copper centres of Arizona and Montana, it is possible to institute a schedule of wages subject to the market price of the metal produced, an easy and most satisfactory manner of handling the question. In Leadville, however, its production of many metals widely differing in value make it impossible to institute a schedule, and makes it very difficult for the operators to arrive at a wage-schedule satisfactory to all. The average value per ton of the ore mined in the Leadville district is \$27.50, but the production from several of the mines nets less than 25c. per ton, while from others it will net \$100. A raise in wages as is now to be asked by the union would shut-down the low-grade properties and put several hundred men out of work. Efforts are being made to adjust the situation before definite steps are taken by the union.

In the issue of November 4 another letter from Leadville will deal with the labor situation in detail.

JOPLIN, MISSOURI

TREATMENT OF TAILING FROM SHORT CREEK

An approach to Western methods is a form of dredging just started by C. J. Rhodes of Joplin, on the sand and gravel bars of Short creek, west of Galena, Kansas. The lower reaches of this stream, just before it enters Spring river, contain long and wide deposits of sand and gravel that are the debris resulting from 25 years' mining operations extending from Central City, Missouri, through Galena, and North Empire, Kansas. A sampling of these accumulations developed the fact that they contained zinc amounting to from 2 to 20%. Mr. Rhodes conceived the idea of building a barge and using a sand-pump driven by Diesel engines as a method of handling

the debris and getting it to a mill upon the bank of the stream. A plant to treat the material is now being constructed with a capacity of 100 tons per day. It will be on the order of a sludge or tailing-mill, similar to the regular type of construction with the exception of a crushing plant. The table-room will start with eight sludge or sand-tables, and part of the larger sizes will be run over sand-jigs. As this method is an innovation in this region it is being watched with considerable interest, as there are other streams in the district that may give equally good results if this operation proves successful.

CHANGSHA, CHINA

RECEPTION GIVEN TO AMERICAN MINING ENGINEERS.

A dinner was given by the Hunan Mining Association in honor of Messrs. F. Searls, G. O. Scarfe, mining experts, the American Consul Mr. Johnson, Mr. McRae of Anderen, Meyer & Co., and several other American residents in Hunan. The dinner party was held in Mr. Wong-Cheng-Tsai's residence, which was beautifully decorated for the occasion.

The first toast, "Chinese-American Friendship" was proposed by Mr. Cheng-Ping-Hwan, director of the Hunan Mining Board, and was well responded by Mr. Searls, who gave some very valuable suggestions regarding the necessary steps which should be taken in order to develop the mineral resources of Hunan, the richest province in China. Mr. Searls remarked that America was only discovered in 1492, and in less than 500 years she had become the greatest mining country and the wealthiest nation in the world. It would not take China very long to develop her industries in the same way if she determined to do so. In conclusion, Mr. Searls wished that the two countries could have more intercourse and do more to develop their trade. He also thanked the hosts for their kind hospitality and wished them every success in their mining enterprise. The speech was interpreted by Mr. C. C. Lu, chief of Technical Department of the Hunan Mining Board. Then Mr. K. C. Li, mining engineer of the Board, proposed "Our Guests," thanking them for their valuable assistance and all kinds of beneficial works done for Hunan and for China at large. Mr. Johnson, the American Consul, responded in a humorous way. He wished that China would have more of her industrial magnates on the political stage with a definite program of industrial development, which was the only way for China to gain prosperity.

JUNEAU, ALASKA

GENERAL CONDITIONS.—KETCHIKAN, JUNEAU, WHITE PASS, COPPER RIVER, AND LA TOTCHE DISTRICTS.—RAILROAD AND COAL.

Alaska, in common with other mining regions, is enjoying the prosperity caused by the prevailing high prices of metals. The year 1916 will record a production greater than in any previous period. This is due largely to the wonderful copper production of the Kennecott mines, also to the increased activity of the low-grade gold deposits near Juneau.

Much development has been done in the immediate vicinity of Ketchikan. This district can be credited with a considerable production of copper, in fact, at present 12 mines are shipping; both to the Granby smelter at Anxox, British Columbia, and to the Tacoma smelter at Tacoma, Washington. The combined output amounts to approximately 10,000 tons per month, the principal shippers being the Granby Consolidated company, operating the Mamie, 30 miles north-west of Ketchikan; the Mt. Andrews property, controlled by New York interests; the Rush & Brown property; the Alaska Industrial Co., whose property is on Prince of Wales island; and the Goodlow Bay mine, owned and operated by J. E. Chilberg, a Seattle banker. The principal ore of this district is chalcopryite, associated with magnetite. Some of the companies are shipping ore that is mined from contact metamorphic deposits,

which carry bornite, epidote, and garnet. The average ore shipped varies in copper content from 4 to 20%, and contains small amounts of gold and silver. The freight-charge to the smelters is reasonable, while the smelter-charge amounts to about \$5 per ton. This district has been examined by several engineers representing the larger exploration companies, but so far no properties have changed hands.

Near Juneau the principal operating companies are the Alaska Treadwell group, the Alaska Gold Mines, the Alaska Juneau, and the Ebner. The Alaska Gold or Gastineau mine is milling 130,000 tons per month averaging \$1.30 per ton, the extraction by concentration being 80%. This property, like others, has been affected by the increased cost of mining-supplies, and the desertion of efficient miners to the more prosperous copper districts. The efficiency of the machine-drillers has decreased 25% since the War commenced; consequently the cost of breaking ore per ton has increased 3c., from 14 to 17c. per ton. At the present time most of the ore sent to the mill comes from the east side of the mine, where the

tons daily. As the mine-development to the east progresses the mill will be gradually speeded-up. Owing to the contour of the ground and the lay of the orebody on the west end, the ore must be taken from certain places first, in order that the mine's producing capacity be not impaired. This work is now progressing rapidly and large bodies of ore of a higher value are being opened for stoping purposes, and within a short time the mill will be operating at capacity, as the company will be able to take the ore from the east end and mix it with the west-end ore, bringing the average to the correct grade."

Work on the Alaska Juneau mill is proceeding. At present almost all the concrete and structural-steel work has been finished, and the mine is being put in order. This company is getting the benefit of the pioneer work done by the Alaska Gold and should be in full operation by the early part of the coming year.

Much activity in mining is to be noted in the territory served by the White Pass & Yukon railroad. At Caribou the Big Thing mine is being re-opened, and along Taku Arm



CHICHAGOF, ALASKA.

gold-content is lower than at the western end, but levels are being driven and raises put through preparatory to working this part of the property. When intermediate levels are driven in the gabbro along the foot-wall, preparatory to stoping, the slate breaks away (sloughs-off) bringing part of the hanging with it, so that the gold-content is lowered by the waste. The management is trying to stop this by working in narrower stopes on the east side, where the ore is richer, mixing the output with the lower-grade supply from the west end of the mine. The company at present is employing 800 men and eventually, when the mine is thoroughly developed, will be able, by merely adding another pair of 72-in. rolls, to supply 12,000 tons per day to the mills. The operating cost is 65c. per ton. This property possesses enormous reserves of low-grade ore; these are measured by an adit 13,000 ft. long and a shaft 1700 ft. to the surface, and a width of ore 85 to 200 ft. A statement recently issued by B. L. Thane applies to the present status of this property and is as follows:

"Since the beginning of the operation of the big mill, the average cost of mining and milling the ore has been under 75c. per ton, which was the original estimate made by the engineers. Eminent men of the mining profession freely predicted that the cost could not be reduced to 75c. as estimated. For the past few months the cost has been 65c. and under. The mill is at present being operated at a 6000-ton daily capacity, which was the original daily estimate, but its actual capacity is more than double that amount or between 12,000 and 15,000

tons daily. The Venus and Engineer mines are being operated. These properties are shipping to the Granby smelter. The Engineer mine was recently examined by representatives of the Tonopah Belmont Development Co. At White Horse, the northern terminus of the White Pass & Yukon railroad, the Pueblo and Grafter mines are shipping 4000 to 5000 tons of ore per month. The Pueblo ore consists of hematite containing 3 to 4% copper, used principally as a flux at the Granby smelter; the Grafter ore is of a silicious character with chalcopryite. In the Atlin district the placers commenced operations in the early part of May, but were hampered by a lack of water later in the season. The operations on Spruce, Discovery, and McKee creeks in this district will produce \$400,000 this season. The gold is valued at \$16.50 per ounce; 500 men are employed during the season.

Along the Copper River & North-Western railroad, 196 miles north of Cordova, is the famous Kennecott mine. This mine is producing about 10,500,000 lb. of copper per month at a cost of 5c. per pound. The ore is found along the contact of limestone and greenstone, in large lenses lying in the limestone about 30 ft. from the contact. The main workings are known as the Bonanza, Jumbo, and Erie, the deepest shaft being the Jumbo, with a depth of 750 ft. Between the 600 and 450-ft. levels on the Jumbo there is a lens of ore 450 ft. long and 150 ft. high, averaging 50 ft. in width. This is first-class ore, and the company is mining it as fast as possible in order to make the most of the high price of copper. The mine employs

350 men, and shipped 8500 tons of ore during the month of August, averaging above 60% copper. There is 20,000 tons of ore, sacked and concentrated, at Cordova, the Pacific Coast terminus of the railroad, ready to be shipped to the smelter at Tacoma.

The Heatson mine, belonging to this same company, is operating a low-grade chalcocite deposit on La Touche island. The mill is being increased to treat 1000 tons per day by the flotation process, the concentrate being sent to Tacoma. The Elkumar mine is shipping 4000 tons per month to the Tacoma smelter. Roy Middlecamp is manager and the mine employs a force of 200 or more. The ore is well oxidized and carries a high gold-content besides about 4% copper per ton. A contract has been let recently for diamond-drilling intended to intersect the vein below the 600-ft. level. The production of the copper mines lying between Cordova and La Touche has been seriously hampered by the lack of steamship-transportation facilities, but this condition will be improved by the recent addition of several new boats by the Pacific Alaska Navigation Company.

On the Government railroad the Alaska Engineering Commission is employing a total of 800 men on the Seward division, 2500 on the Anchorage division, and 500 out of Fairbanks. The old Alaska Northern line is being repaired, and new bridges are replacing the old bridges at Placer and Portage rivers. This railroad will be rehabilitated completely as far as Kern Creek, 71.6 miles north of Seward, by October 30. The work is in charge of R. J. Weir, formerly with the Southern Pacific. From Anchorage the road is completed as far as Matanuska Junction, and thence about 15 miles to Moose Creek, toward Chickaloon, in the centre of the Matanuska coal-fields. The spring of next year will see the completion of this branch road to Chickaloon. At present, under the system of leasing introduced by the Interior department, one coal lease is operated by Richard Doherty at Moose Creek. This property is supplying the railroad with 3000 tons of coal. The restrictive conditions imposed by these leases are such that experienced operators are not attracted. The Willow Creek district, 30 miles north of Knik, was extremely handicapped by the lateness of the spring. At present the Gold Bullion, Independence, Mabel, and Jap properties are being operated. The total production for this district is estimated at \$500,000, and the principal portion of it should be credited to the Gold Bullion. The small veins occur in granite, and the ore in small shoots at frequent intervals. Mining operations can be continued in this district for only six months of the year owing to the hard winters and lack of water for milling purposes. Several prospecting parties entered the Broad Pass district, but no discoveries of any consequence were reported.

SUTTER CREEK, CALIFORNIA

STRIKE SITUATION.—CENTRAL EUREKA LOSS.—OLD EUREKA.

About 200 men awaited the arrival of each train at Martell yesterday, the 21st, the striking miners having heard rumors that a number of miners were to arrive here to take the places of the strikers; but apparently the report was not well grounded, as the expected strike-breakers did not put in their appearance. Attempts have been made to stop merchants, bakers, and butchers from delivering supplies to the South Eureka property, where the company has employed a dozen or more men from the outside to work as guards. These men are camped on the company's ground. At the present time, the Kennedy company has 111 men on its payroll and the Argonaut 100. At the other mines, south of Plymouth, only sufficient men are at work to keep the mines open and make necessary repairs. J. B. Dale, organizer for the State Federation of Labor, has spent several days in the county, endeavoring to get the matters settled by arbitration, but the mine-owners insist that they have nothing to arbitrate, and

are ready and willing to resume operations on the old basis, when a sufficient number of the men express a willingness to return to work. The mine operators have appealed to the U. S. District Court to prevent interference with their operations by striking miners, and Judge E. S. Farrington issued an order today, restraining the strikers from committing violence pending a hearing of the application for an injunction. The companies claim that their property is valued at more than \$1,000,000, and unless their employees can pass freely to and from the mines irreparable damage will result from cave-ins and flooding. Over a month has elapsed since the strike began, and in that time 500 miners have left the county to seek work in other localities.

During September, or that portion of the month prior to the miners' strike, the Central Eureka company reports 1676 tons of ore crushed, yielding 204 oz. of bullion valued at \$3422; concentrate yielded \$2660 for the 22 days' run, and sundry collections brought the total receipts up to \$6138. With the exception of three days' milling after mine operations ceased on the 19th of last month, only pump-men and engineers have been working during the strike. The total expenditure for mining, pumping, and shaft repairs for the whole month was \$4976; milling, \$1043; development, \$1658; tailing dam, \$387; indemnity insurance and sundries, \$841, making a total cost of \$8905, or a net loss on the month's operations of \$2767.

The Old Eureka company is preparing to install a 9000-gal. tank or reservoir at the 500-ft. station, to be supplied by large pumps at 600 ft. and levels below. It is estimated that the lower pumps will have sufficient capacity to fill this reservoir in 18 minutes. A centrifugal pump at the surface will raise the water from the 500-ft. level. Twenty-five men are employed at present in the shaft, and 30 on surface construction and installation of the large hoist.

The new double-drum hoist for the Old Eureka mine arrived during the week and is now in course of installation, the foundations for same, as well as for the new steel head-frame, shortly to be erected, having been ready for over a week. The new hoist is a powerful one, capable of raising 15,600 lb., and being efficient for a depth of 2000 ft., nearly 1000 ft. below the present shaft-bottom. The water has been removed to a point just above the 800-ft. level, and the shaft-men have for some distance found evidence in the way of charred timbers of the fire that caused the closing down of the mine over 30 years ago. The work at the last operating of the mine did not extend below 800 ft., although the earlier working of the mine had yielded well when the shaft was open to 2100 ft. It is expected that the condition of the shaft below the 800-ft. station will be much worse than that passed through above, as that portion also is said to have been burned out a number of years prior to the last operations. Caves in the shaft will doubtless be encountered and more difficulty be met with in re-timbering, but by means of the adequate machinery now being installed the owners appear hopeful of getting the entire shaft unwatered and repaired early in the coming year. Three crews of shaft-men, as well as a large force of mechanics and carpenters, are working steadily in re-opening this old property, which has a record of yielding no less than \$10,000,000 during former operations, when mining and milling methods were crude and operating costs excessive. The superintendent, T. Walter Beam, has recently engaged George Pettigill as foreman.

The elevated track on which cars will carry the ore from the Argonaut shaft to the new mill in course of construction to the west of the present plant, is now being erected. The mill is 800 ft. from the ore-bin at the mine, and two tracks up this steep incline will be used, the descending car helping to balance the ascending one, one man on a shift being sufficient to handle the car system, including loading and dumping. Machinery is being installed in the mill, which will be equipped with 60 stamps, or 20 heavy new stamps in addition to the 40 used until recently in the old mill.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

FAIRBANKS. On September 17 the new Lane mill of 20-ton capacity started work on the Thomas gold-quartz mine at the head of Eva creek. This property has been thoroughly developed. On the road to it are several promising mines.

VALDEZ. After several weeks' shut-down for development of the mine the Granite mill resumed crushing recently. High-grade ore was opened on one level, and good grade on two others.

ARIZONA

(Special Correspondence.)—For the nine months ended June 30, 1916, 873 cars of ore was shipped from Chloride. There are now 40 properties here in active operation and several others soon to be started.

The oldest and most historic property at Chloride, the Silver Hill mine, is again being operated. H. M. Henning, the present owner, arrived here last week and at once started men cleaning-out the old 600-ft. adit. This cut the vein when work was stopped years ago, since then it has not been worked. Bad management was the direct cause of the failures in the past. It was on this property, a long time ago, that three miners were murdered by Indians while working in a shaft. The Indians stood at the collar of the shaft and stoned the helpless miners to death.

The Towne mine has been shut-down awaiting the arrival of the new head-frame, hoist, and compressor, which should be on the ground this week. A new shaft is to be sunk, as the old one is in an unworkable condition. This mine was recently unwatered and sampled, with the result that the owners are highly pleased and purpose to prosecute work vigorously.

The Desert Power & Water Co. expects to have its high-tension line into Chloride within three weeks. Many mines will install electric hoists.

It is said that the new shoot in the Keystone surpasses any heretofore made in this district. On the 300-ft. level 8 ft. of ore assays 226 oz. of silver and 1.4 oz. gold.

A new three-compartment shaft has been started between the Keystone and Silver Keystone properties, so that both may use the same shaft in drawing ore for the new mill that is being constructed.

On the Black Jack property a new adit has been started which will cut the ore at a depth of 450 ft. A contract has been let for the construction of a road from the mouth of Alum Wash to the property. The ore will then be hauled with trucks. Sixty burros are now employed in packing the initial shipment of 250 tons.

The Copper Age has begun excavating for a reservoir. This work is preliminary to the beginning of mill construction under the direction of G. W. Peer. The mill will be in operation by February 1.

Julius Kruschmitt, south-western representative of the Guggenheims, left on October 10 for El Paso, taking with him the samples from the Brunswick, Golden Hammer, and the Holmes properties at Hackberry.

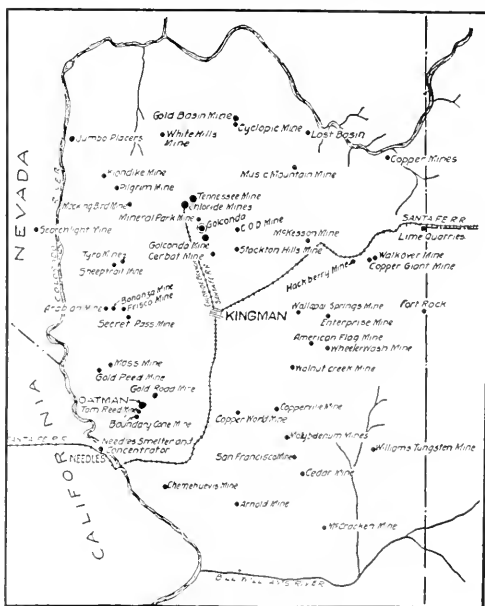
The Tennessee Extension has men at work. It is a close neighbor of the Tennessee, Payroll, and Minnesota-Connor. A contract has been let for an extension of the present adit. Chloride, October 16.

(Special Correspondence.)—Shareholders from Kansas City

and Omaha will arrive at Gila Bend this week for an inspection of the Rowley Copper Mines Co.'s property. The work is being done under the supervision of C. T. Jobes, chief engineer. L. C. Harden of Phoenix is the foreman. A shipment of silver-lead ore made from the new No. 3 shaft to the El Paso smelter last week, returned lead and silver amounting to \$93.96 per ton. Work at the Rowley is being confined to driving along the high lead-silver vein and to deepening the vertical and the No. 3 shafts. Twenty-five men are employed.

Gila Bend, October 15.

JEROME. Within a few months the United Verde Copper Co. will commence mining low-grade surface ore around the old



MINES OF MOHAVE COUNTY, ARIZONA.

smelter at Jerome by means of steam-shovels, and sending it to the works at Clarkdale. Excavation is to proceed to the fire that has been burning for 14 years in the Hampton stope. The fire can then be attacked from above. When No. 5 shaft of the mine is concreted, and the large electric hoist installed, ore production will be augmented. The smelter is soon to reduce 2500 tons daily. A second reverberatory furnace is in commission, also three blast-furnaces.

N. Bertrand of Bisbee has a contract to diamond-drill the Verde Hercules ground to a depth of 1500 or 2000 ft. This mine was formerly the Harryhausen.

HAYDEN. It is reported that the Ray Consolidated Copper Co. is preparing plans for a 6000-ton plant to treat its tailing. The works will be on the banks of the Gila river, and will cost \$500,000.

MIAMI. An employees' grievance committee has been appointed at the Inspiration, with the sanction of the company, to discuss with the management any disputes that may require ventilation.

NEEDLES. Reports state that the Colorado river is running wild, making transportation between Oatman and Needles a difficulty. Several automobiles were caught between the river and water that leaves the main channel when the river is high. Cars are going by way of Topock. Floods at this season are unusual. When the water recedes several miles of road must be re-built.

(Special Correspondence).—On account of certain derogatory reports circulated a few weeks ago in a campaign to bear shares of the Big Jim mine, the management secretly put up a raise a height of 150 ft. from the 400-ft. level. At that point a cross-cut was driven from wall to wall, and both raise and cross-cut are in ore throughout, averaging \$20 and over per ton. There having been no opening in the ore above 400 ft. nor below 485 ft., the bears alleged only ore between the levels could be taken into account in estimating reserves.

The Gold Dust has opened its ore-shoot for a vertical depth of 476 ft. from the surface. As exposed, the ore averages from 1 to 2 oz. per ton in gold. Seven hundred feet north-west of the shaft, surface assays of that value were found several years ago; with that as an object the drift was driven recently. From thence the winze was sunk 76 ft. and is in 2-oz. ore at the bottom.

The Boundary cone has opened a second large shoot of milling ore 560 ft. east of the shaft on the 550-ft. level. One passed through on the same level, with low-grade ore between, is being driven 325 ft. east on the 750-ft. level, and in both faces assays run from \$10 to \$60 per ton. Converging in the Lexington-Arizona ground eastward and passing through the Paramount on the west, these two veins are of the highest significance to the district.

For two weeks the Pioneer has been cross-cutting from the north drift westerly on the 200-ft. level, at a point 200 ft. from the end-line of the Arizona-Tom Reed. Being under the one management the object is to develop both properties. In this area a vein at one point averages \$25 per ton.

The Nellie has made a rich surface discovery, 25 ft. from the boundary of the Black Range and 115 ft. from the spot where the latter made its recent strike. The manager, H. E. Woods, started a shaft and at 2 ft. he opened 5 ft. of ore assaying \$2.48, \$6.61, \$8.68, and \$19.61. Pannings average about \$15, which is a fine surface showing for Oatman.

Oatman, October 15.

OATMAN. The Los Angeles Mining Bureau states that the most important developments of the week ended October 14 relate to Big Jim and Tom Reed mines. The Tom Reed has developed ore in its Pasadena claim a little over a mile north-west of its main workings, and ore has been encountered at 400 ft. depth in its Bald Eagle claim, which extends the known length of the Aztec-Black Eagle vein more than 200 ft. It is estimated by Oatman mining men that the Aztec-Black Eagle vein promises to develop into a greater mine than the original workings of the Tom Reed in its Ben Harrison claim.

It is semi-officially announced by the Big Jim company that the raise from the extreme end of the east drift on the 400-ft. level has resulted in highly important developments. The raise was carried to a point 160 ft. above the 400-ft. level, and at this point broke into extensive lateral work done on the vein by the Tom Reed company, which had been doing exploratory work with reference to it. Grey Eagle claim, adjoining the Big Jim on the south. On this level, which corresponds to the 240-ft. point in the Big Jim shaft, a drift had been put in on the vein for 240 ft., and a raise in the vein for 50 ft. This work was done recently by the Tom Reed company, which, some time ago, did extensive searching in and adjacent to its Grey Eagle claim, adjoining the Big Jim on the

south. The Grey Eagle shaft was put down about 300 ft. vertically. At about 200 ft. a cross-cut was driven to the north, not only to the Grey Eagle-Big Jim side-lines, but into Big Jim ground some 40 to 50 ft., and into the Big Jim vein. At this point the upward extension of the Big Jim vein was inclining somewhat sharply to the south, or towards the Tom Reed ground. It certainly looked as though the Big Jim vein passed through the side-line and apexed on Tom Reed ground. Along the line between the two properties is a strong intrusive dike that at places outcrops boldly at the surface. The raise put up by the Tom Reed showed that when the Big Jim vein reached the vicinity of this strong dike, it folded and bent back toward the north, and at the point where the vein came closest to the Tom Reed ground, it is some 30 to 50 ft. within the Big Jim side-lines. From this point, going toward the surface, the angle of the vein is toward the north, thus indicating that its apex is some considerable distance within Big Jim ground. It is significant that the lower part of the Grey Eagle shaft below this level was filled with refuse matter from operations on that level. A considerable tonnage of Big Jim ore is on the Grey Eagle dump, and the Grey Eagle work and shaft now afford a second outlet and an air passage for the Big Jim workings. Had the Tom Reed not done this work, it would have been necessary for the Big Jim to make a second outlet at its own expense. The second outlet and driving operations on the vein done by the Tom Reed company for them saved the Big Jim company approximately \$25,000 to \$30,000. It is notable that the 240 ft. of driving on this vein by the Tom Reed company extends a known lateral length on this vein 240 ft. beyond the extreme western point at which development in the vein had been done by the Big Jim company. The Big Jim is now doing work in this drift, and superintendent Keating states that it shows a large body of ore which he anticipates will average in value as well as, or better than, the ore on the 400-ft. level. With this new development, the Big Jim ore-shoot has been opened on various levels from the extreme eastern point to the extreme western point, a distance of 700 ft., and shows an orebody of a known height of 245 ft., and which seems to average well above 25 ft. in width. It is stated that the last 45 ft. of new openings in the west drift on the 485-ft. level average in excess of \$40 per ton. These developments are highly significant and still further bear out the opinion of mining engineers who have expressed the belief that Big Jim is developing into a mine which, foot for foot, of development closely parallels the Tom Reed and United Eastern.

Important developments are expected during the next few days on the Iowa, Picture Rock, and Nellie properties. All of these companies are just breaking into their main vein systems, and indications are highly favorable. It now appears as though Oatman is due for important developments in a number of properties at approximately the same time.

CALIFORNIA

HISTOR. The Tungsten Mines Co. shipped concentrate worth \$20,000 last week. The mill is working full time.—Operations at the Standard tungsten mine are progressing steadily.

GRASS VALLEY. The North Star company has distributed No. 3 dividend for the current year, amounting to \$50,000. The total is \$1,937,000. Good progress is being made with plant alterations.

NATOMA. No. 7 dredge of the Natoma company has been righted and is again at work. Some time ago the boat capitalized to put it in commission cost \$150,000. Red-dredging tailing at Oroville is reported to be most satisfactory.

REDDING. A 250-hp. Diesel engine is expected any day at the Midas coal mine in Harrison Gulch. The mine is then to be unwatered to the 1200-ft. level, where a fire occurred in 1913. J. H. Sharpe is president of the Victor Mining & Power Co., the owner.

(Special Correspondence).—The Confidence mine, for many

years one of the most consistent producers of Tuolumne county, is to be re-opened by the Confidence Gold Mines Corporation, which filed articles of incorporation here this week. A decade has passed since the suspension of operations, previous to which the mine regularly employed 40 men. Its total yield is upwards of \$5,000,000. In addition to an 850-ft. incline shaft, from which drifts of varying lengths were driven, there is a winze from the bottom level that is 250 ft. deep. The capital of the new concern consists of 1000 preferred and 5000 common shares of the value of \$100 each. The officers and directors are W. A. Stratta and E. S. Bolen, of Richmond, Va., and Warren B. Hunting, of New York.

After several weeks of continuous pumping the Columbus mine, near Tuolumne, has been unwatered, and with as little delay as possible development will be resumed. The Columbus is one of the oldest properties on the east mining belt, and in its early period of activity yielded considerable gold. The company which now has the property is reputed to be strong financially. It is the general belief that extensive exploration work will follow.

A body of rich ore, 3 to 4 ft. wide, has been uncovered in the Gem mine, operated for the past four years by J. F. Wulzen. The strike was made in a winze sunk near the face of an adit driven many years ago, and is regarded as one of the most important made on the east belt for a long time. Much of the quartz is speckled with gold.

The Buckeye mine has passed into the hands of a New York company and will shortly be re-opened and operated. Half the wages that were due miners when the property closed some time ago were paid recently, and the remainder is promised within 60 days.

Rich ore has been uncovered in the Bacigalupi claim, northeast of Tuolumne. The operators, encouraged by the find, have announced their intention to develop the property to a much greater depth.

A few mines which suspended operations recently on account of a scarcity of water, have been able to resume work as a result of the copious rains of the past several days.

Sonora, October 12.

COLORADO

GEORGETOWN. Lessees at the Capital mine are to ship to the mill or smelter to try the gold ore from the rich shoot in No. 15 rise. A trial run at the mill resulted in the tailing containing 200 oz. per ton. All the other lessees are busy, getting encouraging returns.

Dumps at the Ocean Wave and Equator have been measured, and contain 360,000 tons of \$7 to \$10 ore. There are 42 men employed at the mine.

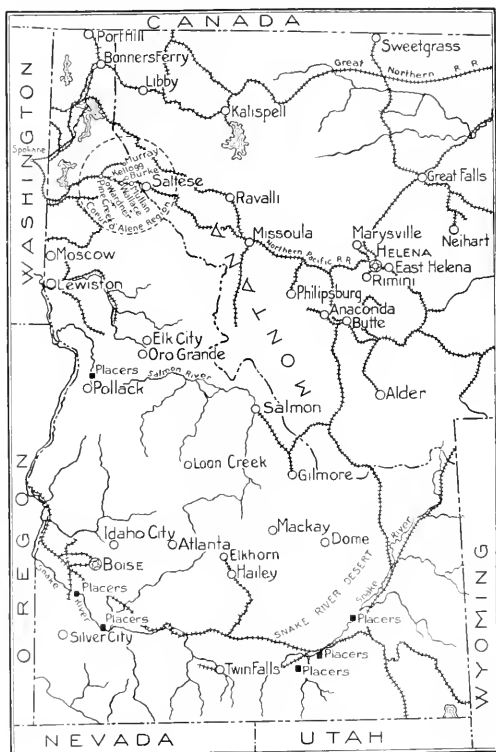
IDAHO

HAILEY. There is more activity in the Wood River district than for many years, the entrance into the field of extensive Eastern capital having given mining a much-needed impetus. The \$40,000 option on the Smoky Bullion group of gold-silver-lead claims, 35 miles west of Hailey, held by the United Mines Co. of Spokane, is to be exercised soon, according to E. A. Worswick of Lovelock, Nevada, owner of the properties.

NINE-MILE. The Interstate-Callahan company is mining up to 15,000 tons of ore monthly, yielding 6500 tons of zinc and lead concentrates. The Minerals Separation company is to install additional flotation apparatus to cost \$50,000. Impounded tailing is to be treated. This will make 800 tons more concentrate. There are 400 men employed, receiving \$85,000 per month. No plans have been prepared for the much-discussed mill at Enaville. The next quarterly dividend is expected to be at the rate of \$1.50 per share.

WALLACE. According to H. C. McAllister, there are perhaps 100 properties in the Coeur d'Alene region, of which the public hears little, that are in the same stage of development today as some of the great producers were 10 to 20 years ago. The

exposures in a large number encourage belief that not a few will ultimately take the place of large present producers.



MAP OF IDAHO.

MICHIGAN

HOCHEM. Copper production of the Culmet & Hecla and its subsidiaries during September was as follows, in pounds:

Mines	September	9 months
Ahmeeek	2,309,955	17,685,686
Allouez	896,184	7,649,473
Culmet & Hecla	6,257,447	57,191,355
Centennial	160,800	1,828,245
Isle Royale	1,010,723	9,226,225
La Salle	119,269	954,489
Osceola	1,700,522	14,935,700
Superior	220,582	2,354,530
Tamarack	512,666	4,949,184
White Pine	385,577	3,280,142

The Hancock company is gradually getting straightened financially. During October there will be over 24,000 tons of ore treated at two mills. The mine is opening well, and 400 men are employed.

At the White Pine Extension development consists of driving north and south at 200 ft., where the average copper-content is 30 lb. per ton.

Another exploration company is to start in Ontonagon county at the Waukulla property, in charge of H. Hillegass.

Allouez is producing at the rate of 12,000,000 lb. per year.

MISSOURI

JOPLIN. The zinc-ore market was stronger last week, the range of prices being from \$62.50 to \$70 per ton for 60% metal-

content. Lead ore was strong, and calamine steady. The Missouri-Kansas-Oklahoma region produced 6478 tons of blende, 720 tons of calamine, and 884 tons of lead, averaging \$61, \$39, and \$80 per ton, respectively. The total value was \$516,654, and for 41 weeks \$26,276,951.

The Norfolk Zinc Corporation, a new company headed by J. M. Short, is to erect a 100-ton mill costing \$40,000, north of the well-known A. W. C. mine. Thirty drill-holes averaged 3% blende at a depth of 175 feet.

MONTANA

BUTTE. For its issue of October 15 *The Butte Miner* publishes 112 pages, most of which are styled as the "Greater Montana Edition." Interesting reading covers mining, power, and other industries. Photographs show leading men of the past and present, mines, and plants. A panorama illustrates the eastern section, now attracting attention. The smaller properties of the district are discussed briefly. Buildings and homes are shown. Transportation systems are described. Historical incidents of the State, as far back as July 4, 1865, at Virginia City, are told. The Governor describes Montana as an "empire of opportunity." Lumber and farming is not omitted from this readable issue.

September at the Butte & Superior was a normal month, all shafts and machinery being in good order. The mill treated 50,150 tons of ore assaying 15.5% zinc. The 13,650 tons of concentrate contained 53.1% metal. The recovery was 93.46%.

The north vein in the North Butte promises to be of importance, as two cross-cuts have opened ore assaying 10% copper and 30 oz. silver per ton.

Additions to the Butte-Detroit mill are complete. A flotation plant similar to that at the Butte & Superior has been ordered.

The Timber Butte mill of the Elm Orlu Mining Co. is to be enlarged by 1000 tons daily, making a future capacity of 2500 tons.

At a depth of 1600 ft. in the Butte & London property the first 10 ft. of the new lode assays 10 oz. silver and 1% copper. A heavy flow of water has delayed cross-cutting. It is thought that the shoot is an extension of the Colusa vein of the Anaconda.

(Special Correspondence).—Contracts have been let by the Three Forks Portland Cement Co. for the erection of a 24-room hotel, store, offices, and other buildings at their new town of Hanover, 7 miles from Lewistown. The company town will have its own water-works, sewer system, lights, etc., and is expected to soon have a population of 300, as about 100 men will be employed at the plant. The new cement plant will cost \$600,000 and will have a capacity of 1200 bbl. daily. The works will be known as plant B of the Three Forks Portland Cement Co., plant A being at Trident. Plans for the machinery and plant are being completed at the general offices. The limestone for the cement will come from the South Moccasin mountains by a 14,000-ft. tram that is estimated to cost \$100,000. It is expected that the new plant will be in operation some time next year. The gypsum mill near Lewistown, also owned by the Three Forks company, is shipping 100 tons daily of exceptionally good product.

The United States Gypsum Co. announces that it will build a gypsum mill, as soon as possible, 10 miles east of Lewistown near Heath, a station on a branch of the C. M. & S. P. A spur-track will be built at once. About 25 men are employed in opening a mine on a lease of 300 acres there. The gypsum is of high grade, and occurs in a bed 11 ft. thick, of which 8 ft. is easily workable. The amount of gypsum in reserve is estimated at 7,000,000 tons.

Mining is quieter in the North Moccasins than six months ago. The orebody in the Barnes King property has proved to be narrow and of lower grade in depth. The ore from the upper levels, however, has continued of the usual grade. The

Fergus County mines have in past years been rather free of fatal accidents, but six fatalities have occurred this summer at the Kendall mines at various times from falls of rock. Two were killed at different times in the open-cut of the Kendall mine; the others in the Barnes-King. The North Moccasin, Piegan-Gloster, and Shannon mines of the company in September produced a total of \$60,600 from 6749 tons of gold ore. This is nearly double that of August.

Sutter brothers and Noble have shipped a second car of 5 tons of copper ore to the smelter at Anaconda, from their claims on Arnell's creek in the Judith mountains. The ore will average nearly 15% copper. The shaft from which most of the copper has been taken so far is about 30 ft. deep, and still in ore. The ore-shoot appears to be of the contact metamorphic type, and is 12 ft. wide. An old prospect tunnel below the shaft, said to be 200 ft. long, is being cleaned-out and will be extended in an attempt to cut the shoot in depth. If this proves successful it would prove the existence of several thousand tons of ore, and permit the mining of it more economically. A few tons of lead ore was mined and concentrated by hand from these claims 30 years ago. Recently both zinc and manganese ore has been found.

Lewistown, October 10.

SUPERIOR. Monthly profit of the Intermountain Mining Co. is now \$17,000. Crude copper ore and concentrate are shipped. Mine developments are good, and dividends are now regular.

NEVADA

GOLDFIELD. Two encouraging developments are reported from the Jumbo Extension mine, one at a depth of 770 ft., the other at 1017 ft., the deepest level.

MINA. The Drew & Farnham quicksilver mine, 14 miles east of this place, has been bonded to F. M. Manson of the Utah Ore Sampling Co., and others. A wide vein of high-grade cinnabar is said to be opened. A small furnace is treating about one ton daily, yielding two flasks of mercury.

The Silver Dyke tungsten mines in Mineral county will be closed down on November 15 owing to the impossibility of producing at a profit under present market conditions.

TONOPAH. Two transactions were recorded last week: (1) the Belmont acquired control of the Panama-Pacific ground on the east, and (2) the Extension bought the Sully property on its north boundary.

YERINGTON. At the Walker River Copper Co.'s Empire Nevada property a 20-ton leaching plant is soon to be erected. G. H. Cogswell is supervising construction.

UTAH

MILFORD. As a considerable quantity of low-grade lead-silver ore has been opened in the Antelope Star mine, 20 miles north-east of this place in Beaver county, a mill is proposed for next spring. High-grade shipping ore is being mined for the smelter.

From the Creole mine in the Lincoln district, where work was started with \$200 cash outlay, lessees have shipped 4100 tons of ore yielding \$41,304. The company now has charge, with J. M. Reynolds as manager.

TINIC. The eastern belt is more active than ever before, employing more men, and shipping lead-silver ore.

WASHINGTON

(Special Correspondence).—The largest quantity of ore ever shipped out of this district in a week was dispatched last week, the total from four properties being 1250 tons. The Lone Pine sent 700; Knob Hill, 300; Hope, 100; and Rathfon Reduction Works, 250 tons. The Last Chance mine, owned by the Lone Pine Surprise company, is to be opened by a 500-ft. shaft, already started. An L-R compressor, 85-hp. boiler, and 35-hp. Vulcan hoist are being installed.

Republic, October 11.

CANADA

BRITISH COLUMBIA

TRAIL. A year ago there were 900 employed at the Consolidated M. & S. Co.'s smelter; today there are 1600, according to H. Wright of Nelson and Trail. Ore sent from both sides of the international boundary are increasing all the time.

ONTARIO

COBALT. During September the Nipissing produced silver worth \$236,873 from 175 tons of high and 6602 tons of low-grade ores. The two mills yielded \$132,753 and \$104,120, respectively. The refinery shipped 566,703 oz. of bullion, some of it from custom ore. Development was generally satisfactory.

In the quarter ended September 30 the Temiskaming Mining Co. did 1054 ft. of development. The main shaft has reached a depth of 1325 ft. There is approximately 300 ft. farther to sink before the lower contact between the diabase and keewatin formations is encountered, when lateral development will be commenced. On the upper levels of the property work is progressing favorably. In storage, at smelters, and at the mine there is a total of 707,287 oz. of silver. Cash amounts to \$25,074. On November 22 there will be \$75,000 distributed.

Most people consider veins at Cobalt in inches, but in the Kerr Lake mine one vein is 20 ft., another 30 ft., while where No. 10, 15, and 8 veins junction the width is 100 feet.

MEXICO

NUEVO LEON

(Special Correspondence).—The alleged existence of an American zinc-trust in Mexico is to be investigated by a special commission, representing the de facto Government, to be appointed by Carranza, according to advices received here from Mexico City. It is stated that Carranza's attention was called to the combination which is said to have been entered into between the American Metals Co., Compania Minera y Compradora de Metales Mexicana, S. A., Empire Zinc Co., Compania Minera de Penoles, S. A., Compania Minerales y Metales, and Granby Mining Co. to control the price of zinc ore in Mexico, as alleged in the petition which the San Roberto Mining Co. recently filed in the district court at El Paso for \$1,900,000 damages against these companies. The complaints set forth that the defendant companies have secured control of the markets in Mexico and the United States for zinc ores "with unlawful intent to monopolize the zinc business." Men who are close to Carranza say that he has been waiting an opportunity for some time to commence proceedings with the view to ridding Mexico of the mining, smelting, and other alleged trusts that he claims are operating here. While there are no specific laws prohibiting combinations of interests for the purpose of fixing prices or restraining trade in this country, a way will be found, it is stated, for meeting the situation. It is claimed that not only the Roberto Mining Co., but many other zinc operators in Mexico, as well as miners of other metals here, have been forced to accept exceedingly low prices for their ores by the combines that control the markets. The Compania Minera y Compradora de Metales Mexicana, Compania Minera de Penoles, and Compania Minerales y Metales each operate large mines in Mexico. The mines of the Compania Minera de Penoles at Mapina, in the State of Durango, are among the heaviest producers in the country. All of these properties have been kept in operation with but slight interruption all through the revolutionary troubles.

Monterrey, October 13.

The College of Engineering at the University of Illinois, Urbana, reports that the number of students registered is 1143, out of a total of 5214 at the whole institution.

The University of California has 6400 students on the register.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

F. L. SIZER is in the Coeur d'Alene.

JESSE SCOBIE is on his way to Bluefields, Nicaragua.

GEORGE A. TWEDDY was here last week from Los Angeles.

POPE YEATMAN has returned from Cripple Creek to New York.

E. L. NEWHOUSE visited the Butte-Duluth property at Butte recently.

EDWARD L. DUFORCQ has moved his office in New York to 18 Broadway.

COREY C. BRAYTON will be in Utah and Idaho during the next two weeks.

RALPH NICHOLS has been in the Genesee district, in Plumas county, California.

W. G. MILLER and T. F. SUTHERLAND have returned to Toronto from New Caledonia.

ARTHUR JARMAN is sailing from Auckland, New Zealand, on November 3, proceeding to London.

FORBES RICKARD passed through San Francisco from Lovelock, Nevada, to Arizona, on October 24.

J. D. HELM, formerly at Mexico City, has been examining copper mines in Plumas county, California.

W. BURLING TUCKER, of the California State Mining Bureau, has moved from San Francisco to Los Angeles.

C. H. MACNUTT has obtained a commission with the Royal Canadian Engineers and expects to go overseas shortly.

A. P. ALLEN has resigned from the service of the Calumet & Hecla, and is now with the Highland Mining Co. at Ashcroft, B. C.

E. H. HAMILTON has been appointed metallurgical manager for the Trail smelter of the Consolidated Mining & Smelting Co. of Canada.

ROBERT MCGARRAUGH, formerly mine superintendent of the Aguacate mines in Costa Rica, has been promoted to general superintendent.

PERNSOR G. SPILSBURY, general manager of the Aguacate mines in Costa Rica, has moved to New York, with offices at 55 Liberty street.

J. L. MCALLEN has resigned as superintendent of the Gold Bullion mine at Knik, Alaska, and will engage in private practice at Portland, Oregon.

CHARLES W. NEWTON, manager for the Consolidated Interstate-Callahan Mining Co. at Wallace, Idaho, was in southern Idaho during the past week.

W. FRANK GRACE, manager of the Waihi Grand Junction mine, New Zealand, has been seriously ill. He has gone to Sydney, Australia, to recuperate.

F. W. SPERR, professor of mining in the Michigan School of Mines at Houghton, is at Detroit attending the fifth annual meeting of the National Safety Council.

WILL L. CLARK has resigned as manager of the United Verde Copper Co. at Jerome, Arizona. ROBERT E. TALLY, for eight years superintendent of mines for the company, is Mr. Clark's successor with the title of assistant-general manager.

W. C. MADGE arrived at Spokane on October 17 from the Ridder mining concession, Siberia. He will be in America for about a month, after which he returns to London to the headquarters of the company, the Irtysh Corporation, Limited.

F. N. FLYNN, for the past seven years connected with the Arizona Copper Co. at Clifton, on October 31 resigned his position as superintendent of the smelting department. ROGER H. HATCHETT, who has been Mr. Flynn's assistant for six years past, has been appointed acting superintendent of the department. Mr. Flynn sails early in November from New York to Chuquicamata, Chile, where he will enter the employ of the Chile Exploration Company.

THE METAL MARKET

METAL PRICES

San Francisco, October 24

Antimony, cents per pound	14.00
Electrolytic copper, cents per pound	29.25
Pig lead, cents per pound	7.25—8.50
Platinum: soft and hard metal, per ounce	\$90—91
Quicksilver, per flask of 75 lb.	\$89
Spelter, cents per pound	12
Tin, cents per pound	42
Zinc dust, cents per pound	20

ORE PRICES

San Francisco, October 24

Antimony, 50% metal, per unit	\$1.00
Chromite, 40% and over, full cars California, per ton	13.00—16.00
Magnetite, crude, per ton	8.00
Manganese, 50% (under 35% metal not desired)	14.00 and up
Tungsten, 60% WO ₃ , per unit	17.00—20.00

New York, October 18

Antimony. Quotations are unchanged at \$1.10 to \$1.25 per unit, but nothing is stirring in the absence of arrivals.

Molybdenum. The supply of ore is small and uncertain. The quotation is unchanged at \$1.50 to \$1.75 per lb. for molybdenum sulphide.

Tungsten. The market continues active, with Europe the principal buyer. All told, several hundred tons have changed hands. High-class material is quoted at \$17 per unit, but inferior ore has been sold at \$11.50 to \$15. The market for ferro-tungsten is active, export inquiries in particular being numerous. It is quoted at \$2.70 per lb. of contained tungsten.

EASTERN METAL MARKET

(By wire from New York.)

October 24. Near-by copper is scarce, and futures are fairly active, lead is quiet, though strong, for spelter galvanizers are active, but sellers are reserved.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Oct. 18	67.25
" 19	67.25
" 20	67.25
" 21	67.25
" 22 Sunday	67.25
" 23	67.25
" 24	67.25

Monthly averages

Date	1914	1915	1916
Jan.	57.58	48.85	56.76
Feb.	57.53	48.15	56.74
Mar.	58.01	50.61	57.89
Apr.	58.52	50.25	61.37
May	58.21	49.87	74.27
June	56.43	49.03	65.04

While the past week's prices show a downward trend, the tone is good. Samuel Montagu & Co. write to the London market that it is a singular fact since the middle of July, when silver may be said to have recovered from the shock of the devaluation last May, when it was announced that the Allies had wisely decided not to make their purchases of gold in competition with each other, that prices have been steadily on the new high figure when that has not been a general rule.

On the 21st silver worth \$132.95 was sent from San Francisco to California. Stock at Shanghai is now 1,000,000 oz. In bars, a reduction of 100,000,000 oz. has been ordered to India.

COPPER

Prices of electrolytic in New York, in cents per pound

Date	Average week ending
Oct. 18	28.00
" 19	28.00
" 20	28.00
" 21	28.00
" 22 Sunday	28.00
" 23	28.00
" 24	28.00

Monthly averages

Date	1914	1915	1916
Jan.	24.21	13.60	24.30
Feb.	14.46	14.38	26.62
Mar.	14.11	14.80	26.65
Apr.	14.19	16.64	28.02
May	13.97	18.71	29.92
June	13.60	19.75	27.47

Refinery production of the country during September totaled 160,000,000 lb. This is a slight recovery, but 30,000,000 lb. below the May yield. It is estimated that the year will produce 2,100,000,000 lb., an increase of 28%.

Kennecott in September produced 8,000,000 lb., a decrease of 2,200,000 lb.; Old Dominion, 3,011,000 lb.; Granby, 3,440,035 pounds.

Apart from the claim by Russia of \$1,140,000 against the Tennessee Copper Co., and other claims in dispute, the company owes banks and others \$1,500,000. Since January 1, 1915, over \$2,500,000 has been spent on new plant. A new stock issue is being made to pay off this debt.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Oct. 18	7.00
" 19	7.00
" 20	7.00
" 21	7.00
" 22 Sunday	7.00
" 23	7.00
" 24	7.00

Monthly averages

Date	1914	1915	1916
Jan.	4.11	3.73	5.95
Feb.	4.02	3.83	6.23
Mar.	3.91	4.04	7.26
Apr.	3.86	4.21	7.70
May	3.90	4.24	7.38
June	3.90	5.75	6.88

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Oct. 18	9.67
" 19	9.55
" 20	9.67
" 21	9.67
" 22 Sunday	9.67
" 23	10.00
" 24	10.17

Monthly averages

Date	1914	1915	1916
Jan.	5.14	6.30	18.21
Feb.	5.22	9.05	19.99
Mar.	5.12	8.40	19.40
Apr.	4.98	9.78	16.62
May	4.91	17.03	16.01
June	4.81	22.20	12.85

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Oct. 18	78.00
Oct. 19	78.00
Oct. 20	78.00
Oct. 21	78.00
Oct. 22 Sunday	78.00
Oct. 23	78.00
Oct. 24	78.00

Monthly averages

Date	1914	1915	1916
Jan.	29.25	51.90	22.00
Feb.	29.00	60.00	29.00
Mar.	29.00	78.00	21.00
Apr.	28.00	72.00	14.60
May	28.00	75.00	30.00
June	28.00	30.00	71.70

TIN

Price in New York, in cents per pound.

Monthly averages

Date	1914	1915	1916
Jan.	37.80	41.40	41.72
Feb.	37.80	47.22	42.50
Mar.	37.80	48.76	50.50
Apr.	37.80	48.25	51.49
May	37.80	48.28	49.10
June	37.80	40.26	42.07

Eastern Metal Market

New York, October 18.

Quiet has been the chief characteristic of the market, a condition that some members of the trade attribute to the recent raids by a German submarine off the New England coast, but which probably is quite as much due to the fact that heavy buying cannot go on forever. Consumers are covered, some of them well into next year, therefore they stop buying.

Copper continues dull, though strong.

Zinc has declined a few points, but producers are satisfied with the manner in which it has resisted any radical decline.

Lead is quiet and steady, with all interests quoting near the same level.

Tin is easier because of selling by small holders who thought it best to take their profits.

Antimony has been more active on Canadian account, and its quotation is higher.

Aluminum is easier following a cessation of export buying. The steel mills continue overwhelmed with the demand for ship plates, many thousand tons of which are wanted on the Pacific Coast. For these plates, 4 to 4.50c., Pittsburg, is asked, whereas ordinary tank-steel can be had at 3.50 to 4c., Pittsburg. Marine-boiler steel is quoted up to 8 and 10c. per lb., Pittsburg. Structural shapes are quoted at 2.85c., Pittsburg, but 3.50 is asked for ship shapes. Steel bars are around 2.70 to 2.75c., Pittsburg. How the high cost of structural shapes and other building materials is halting new construction is evidenced by the September report of the Bridge Builders and Structural Society (made up of independent fabricators), which shows that the business taken by its members in that month amounted to only 52½% of capacity, against 64% of capacity in August. Despite this interesting statement, there is ample opportunity to dispose of every pound of steel the country can produce. An unprecedented quantity never gets to the finished stage. Pig iron continues to gather strength, not only because of demand but because of increased cost of production. Coke is scarce and high because of insufficient cost of production. Coke is scarce and high because of insufficient labor in the coke-making districts and a shortage of freight-cars wherewith to transport the product. As a result, blast-furnace managers have been compelled to enter the open market for spot coke and some have paid \$5 per net ton at oven.

Makers of machine-tools continue to advance prices, although the full tide of war business has passed, and their dealings are now principally with domestic industrial buyers. It is difficult to point to any commodity that is not higher in price.

COPPER

Prices are steady, but the market is dull, and features of interest are wanting. Large consumers have covered their requirements for the remainder of the year, and many have done so for the first quarter of 1917. Consumption is going forward on an enormous scale in brass and copper-rolling mills, munition plants, and wherever copper is used. Hot-rolled sheet copper is quoted at 37.50c. per lb., delivery at mill's convenience; cold rolled at 38.50c. Copper rods are quoted at 43c., and copper wire at 32.50 to 33c., according to delivery. Brass sheets range from 42 to 46c., and wire and light rods from 45 to 48c. Electrolytic copper is quoted at 28.50 to 29c. for nearby delivery. November and December at 28 to 28.25c., and first quarter at 27.25 to 27.50c. Lake, for nearby delivery, is a shade under electrolytic. But little copper is held by second hands, and it is predicted that they will endeavor to depress the market in order to acquire the metal advantageously. The producers are so well sold-up, however, that prices are likely to remain steady for some time.

As heretofore said, the elimination of the Allies from the market for many months will have a steady influence. The London market is unchanged at £143 (for electrolytic), compared with £142 a week previous. Exports this month, up to and including October 17, total 11,052 tons. Stocks in Great Britain and France, on the 15th totaled 5620 tons, against 5796 tons on September 30. Including the stocks from Chile and Australia, the total European supply, on October 15, was 10,670 tons, against 10,371 tons at the end of September.

ZINC

In a quiet way a fair but not large business in spelter has been done. Prices are a little lower, although they have resisted the tendency to decline in a manner considered satisfactory by sellers. Prices quoted yesterday for October and November were about 9.62½ to 9.75c., New York, and 9.50 to 9.62½c., St. Louis. There is some show of interest on the part of the brass mills, but they have yet to take hold in a way that will mean business—and higher prices. The export demand is not heavy. Producers say consumption is nearly keeping pace with production. One of the puzzling features is that the galvanizers are known to be operating far below capacity, some estimates placing the rate of operation at about 35%. There can be no question as to the consumption of spelter, and the real question is—where is it going? Exports, of course, continue heavy, amounting this month to date to 4645 tons. The London quotation yesterday was £53, against £56 a week previous. The quotation for sheet zinc in car-load lots, is unchanged at 15c., f.o.b. mill, 8½ off for cash.

LEAD

The dull but steady market has remained unbroken, and neither independents nor the leading interest have made any change in their quotations. The A. S. & R. Co. quotes 7c., New York, and 6.92½c., St. Louis, while the outsiders ask 7c., New York, and 6.85c., St. Louis. Reports were current yesterday of a betterment in demand, but if it existed it could not be easily found. The general observation is that consumers are content merely to watch the market, while producers show no anxiety to sell. The London quotation yesterday was £30 10s., against £30 15s. a week previous. Exports to the 17th totaled 2412 tons. Government statistics recently issued show the total production of lead in the United States in 1915 to have been 550,055 tons, the largest on record, comparing with 542,122 tons in 1914, and 462,460 tons in 1913. Last year's production consisted of 388,594 tons of desilverized and 161,461 tons of soft lead.

TIN

A desire on the part of small holders to take profits has made prompt tin easier. The easiness was helped along by the arrival of steamers with considerable stock, one boat, the *City of Naples*, from Singapore, bringing 450 tons. On one or two days fair sales were made, but for the most part the week has been a quiet one. Most of the buying involved futures, and included Banca tin for November shipment from Batavia. The differential between Straits and Banca is not as wide as usual. Spot Straits was quoted yesterday (the 17th) at 40.75c., whereas spot Banca could be had at 40.50c. Most of the Banca is firmly held by London houses, despite its Dutch origin. The arrivals this month total 1630 tons, and there was afloat yesterday 1900 tons.

ANTIMONY

Canadian interests are reported to have taken several hundred tons of Oriental brands, in bond, last week, with the result that considerable strength was imparted to the market. Current quotations range from 13 to 13.50c., duty paid.

Mining Decisions

SEVERANCE OF MINERALS—SUBJUNCT SUPPORT

Where a land-owner conveys the surface of land reserving to himself the right to mine and extract the coal and other minerals underneath, the grantee of the surface is entitled to subjunct support of his land and the owner of the mineral rights must leave enough pillars to furnish such support.

Stonestap Colliery Co. v. Hamilton (West Virginia), 89 Southeastern, 305. June 8, 1916.

OIL LEASE—LESSOR'S ELECTION OF REMEDIES

Under the terms of an oil lease the lessee was required to drill a well or pay \$50 per month rental in lieu thereof. On his failure to do either the lessee might elect to either forfeit the lease or sue for rentals thereunder as they became due. Until a forfeiture was formally declared or a release made after notification by the lessee, the lessor was at liberty to pursue his action for rentals accrued but not paid.

Clemenger v. Flesher (Texas), 185 South-western, 304. March 18, 1916.

OIL AND GAS LEASE—LESSOR'S REMEDIES

Where an oil and gas lease provided that the lessee thereunder should complete a well within six months from the date thereof, or pay the lessor rental at the rate of \$20 per month, the provision is for the benefit of the lessor only, and he alone may elect whether to cancel and terminate the lease or to stand on its terms and sue for rentals due up to the time the premises are re-conveyed or until the term expires.

McKee v. Grimm (Oklahoma), 157 Pacific, 308. May 16, 1916.

PETROLEUM WITHDRAWALS—SUBSEQUENT ENTRY

Petroleum lands that had been withdrawn from entry by order of the President of the United States prior to an actual discovery of oil thereon are the exclusive property of the Government. Oil companies who entered thereon, and discovered and extracted oil subsequent to such withdrawal order, under leases from persons who had made paper locations prior to the date of said order were held to be trespassers, were perpetually enjoined from further operation, and were required to account to the Government for the value of oil already extracted, less the cost without profit of extracting the same.

United States v. Midway Northern Oil Co. (California), 232 Federal, 619. May 1, 1916.

EXTRA-LATERAL RIGHTS—PROOF OF APEX

When the apex within a claim is terminated by a fault, such a termination limits the boundaries of the extra-lateral plane unless the apex recurs on the other side of the fissure and within the boundaries of the claim. Where the determination of the apex issue rested upon expert testimony as to the classification of the mineral found in the apex as quartzite or limestone and such determination could only be had through microscopic examination, the Court will not substitute its own judgment based on a personal examination of the ground in dispute for the testimony of experts even though the latter be in conflict. The limestone zone lying between a hanging and a foot wall of quartzite was held to be a broad vein or lode apexing in defendant claim, and lying a well-defined continuant, to and including the orebody. In dispute.

Wall v. United States Mining Co. (Utah), 232 Federal, 619. May 1, 1916.

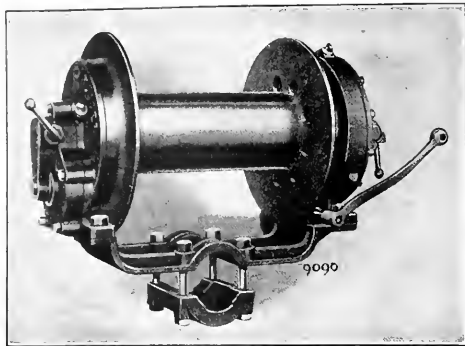
Industrial Notes

Information supplied by the manufacturers.

A New Model Little Tugger Hoist

For the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Company of New York has devised a new model 'Little Tugger' hoist which is designated No. 11.

The square piston, reversible driving engine, automatic lubrication, enclosed gearing, drum-release clutch, and worm-



THE NEW LITTLE TUGGER HOIST.

operated hand-brake are essentially the same as in the No. 1 model, which was described on page 624 of the PRESS of October 17, 1914. The main differences are in the diameter and length of the drum, the width of the flanges and, necessarily, the main frame and overall dimensions. The new No. 11 has a hoisting drum 7 in. diam. by 17 in. long, with 5-in. flanges. This accommodates 300 ft. of $\frac{3}{4}$ -in. manila rope. The maximum capacity of this hoist is conservatively rated at 600 lb. The weight of the hoist itself is 358 lb. It is 21½ in. long, 31¼ in. wide, and 23 in. high. Like the No. 1, the No. 11 machine is designed for operation both by compressed air and steam. The standard clamp fits a 1½ in. diam. column or pipe, but by removing the clamp the hoist can be readily bolted directly to any convenient support, timber, or flooring.

Although designed primarily for underground work, it is recommended by the manufacturer for general hoisting, hauling, and handling in mines, tunnels, quarries, and industrial plants.

P. H. RIMMOX desires to announce that he has disposed of his entire interest in General Machinery & Supply Co. and that, pending the occupancy of permanent quarters, he has opened temporary offices in the Hooker & Lent Bldg., 503 Market St., San Francisco, for the purpose of engaging in the business of compressed air and general machinery, specializing on prompt and efficient service for everything pertaining to mine equipment and supplies. Correspondence is solicited. On and after November 15 the firm will be established in its permanent office at 57 First street, San Francisco.

The General Electric Co. is now manufacturing a new type time limit over and relay of single-pole design. It is said to be particularly applicable to those systems where extreme accuracy in timing is required for tripping two or more air or oil circuit breakers collectively.

EDITORIAL

T. A. RICKARD, Editor

FORTY-ONE pesos are needed to buy one American dollar. This matter of exchange is paralyzing business in Mexico. Meanwhile Carranzistas, Legalistas, Zapatistas, and Villistas are exhausting the life of the country without any promise of a combination of parties to restore order.

EQUANIMITY marks the public temper on the eve of the Presidential election. It is not believed that the result will affect the general prosperity, which is today influenced mainly by events outside the United States. The one thing to cause violent perturbation would be the cessation of hostilities in Europe. When that comes we shall see a sharp break in the price of metals and a rise in the price of cotton. What the further effects will be nobody knows; the prophets were stultified by their predictions at the beginning of the War.

DIRECTORS of Stratton's Independence, Ltd., the English company that formerly owned the famous mine discovered by W. S. Stratton at Cripple Creek, were given four months in which to find a new property "in one of the Allied countries, preferably Russia." We learn that the search for a fresh venture has ended in an arrangement to participate in a new enterprise known as the Altai Concessions. The Altai is a mineral region that is sure to attract increasing attention. We published an article on this part of Siberia by Mr. H. W. Turner in our issue of June 26 last year.

ON another page we give reasons for labeling the New Modderfontein the greatest gold mine in the world. Since that editorial was written we have received the company's report for the year ending June 30, 1916. This confirms all that we have said and therefore calls for no corrections. The profit earned in the last fiscal year was £766,200, as compared with £692,100 in the previous year. This gain was due largely to an improvement in the yield to 40s.10d. or \$9.90 per ton. New ore 'developed' during the year amounted to 1,764,000 tons averaging 11 dwt. per ton, and the reserve was increased to 8,013,400 tons, averaging 8.4 dwt. per ton. Delay in the delivery of machinery will prevent the completion of the new plant until the end of next year.

LOSSES and gains due to the War are difficult to appraise. One source of loss is not appreciated: the decline of immigration. We are losing a million immigrants per annum owing to the War in Europe, where

30,000,000 people have been under arms for two years. Each immigrant into the United States is estimated to increase the national wealth by an amount ranging from \$500 to \$1000 annually, so that the check to immigration is costing us about \$750,000,000 per annum. Nobody knows what will happen when the War ends: whether emigration from Europe will be resumed in its former volume or not. The general surmise is that England, Germany, and France will retain their people but that Poland, Hungary, and the Balkan countries will emit a large flood of unfortunates across the Atlantic. In any event, a great shock to the labor market is inevitable when hostilities cease, and with it will come a re-opening of the entire labor problem.

WE have received a circular letter signed by a group of distinguished members of the engineering profession asking us "to call attention to the importance of electing a Republican administration in November." That we cannot do, because this is a non-partisan paper. The interest of our readers in Mexican mining affairs, however, is so large that we feel justified in quoting the statement made by Mr. Hughes: "An American in Mexico is subject to Mexican law, but he is an American still and is entitled to the protection of his own government in his lawful business. For one, I shall never consent to a policy which leaves Americans helpless against the lawlessness of any country in which they have a right to do business." We were glad to read this statement of policy by the Republican candidate and we hope the time may come when it will cease to be a political issue.

PAPER has risen so much in price that the newspapers have been compelled to reduce their bulk. Recently the New York Times, truly a splendid newspaper, announced that it had to omit 24 columns of advertisements. The crisis in the paper market may prove a not unmixed evil if it leads to an abatement in the lavish printing of silly supplements and society flapdoodle. Even the technical press, which is relatively far less voluminous, might learn a lesson. The average reader, especially among the younger men, does not realize how much his technical paper has increased in size during the last 20 years. Some of that increase represents a gain of information, but a part of it, as in the daily newspaper, is only padding. In this matter the public taste has been spoiled; bigness is mistaken for worth, a mere mass of printed matter is confused with value received in the form of intelligent comment, interesting

descriptive matter, or current news. One result has been the submergence of the technical man under a flood of half-baked indigestible print, against which he hardly knows how to protest. Engineers talk a lot about efficiency, but they fail to realize how inefficient the technical literature of the day has become. Perhaps the paper famine will serve as a salutary discipline.

FRENCH and American mining companies in Korea are having trouble over the labor question. The Japanese are claiming the right to supply the necessary labor; in other words, to sell labor under a contract that prevents the European management from dismissing its employees at will. At the Nampui mine, on the French concession, this labor contract was opposed until recently, when the manager was forced to accede to the demands of the Japanese, at the point of a gun. At the Tul Mi Chung mine, of the Seoul Mining Company, a serious crisis was reached during the first week of October. A number of low-class Japanese had been trying to persuade the management to allow them to supply labor under contract. After sundry interviews, these Japanese threatened the manager, Mr. W. T. Hall, and later swore to kill him and the company's interpreter, a Japanese, and also Mr. A. R. Weigall, the consulting engineer. Fortunately a number of Japanese in the employ of the company proved loyal and the other members of the American community, being forewarned, were able to arm themselves so as to prevent attack. On the same day an attack was made on the bullion escort from the Oriental Consolidated, and Mr. Wellhaven, a brother of Mr. Alf. Wellhaven, the general manager, was killed, while Messrs. Williams and Barstow were wounded. The company policeman and the driver of the buckboard were also killed, but the bandits did not get the bullion. It is hoped that the Japanese government will realize its responsibility and put an end to this continued threat against the Korean mining companies that are operating legally under its benevolent sanction.

TESTIFYING before a Government commission at Johannesburg, Mr. R. N. Kotze, until recently the Government Mining Engineer, states that the chief drawback to the State undertaking mining operations was the possibility of financial loss, as it could not be presumed that all the areas in the East Rand would prove profitable. The State would be unable to make as large a profit as an individual or company, nor would it be able to command the highest technical talent on the usual Governmental salaries. Political interference would be another objection; also the probability of disputes with employees. Finally, he suggested that the absence of the share market as an element in State exploitation of the gold mines would enormously restrict enterprise. Much sagacity is to be detected in this testimony. Of course, the share market always affords an avenue of escape for the incubator of an unfortunate mining enterprise, giving him a chance to pass his 'investment' to simple-minded persons not aware to the

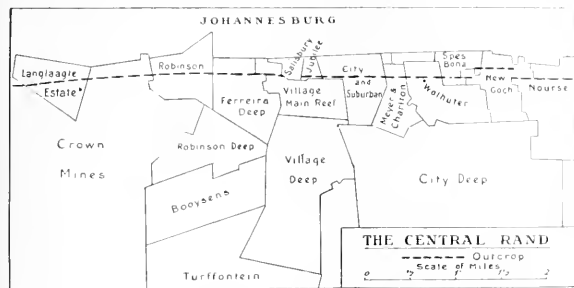
realities of the 'game.' If everybody went into mining like a State acting under the advice of Mr. Kotze, there would be less money wasted on worthless projects and less inflation of shares when a rich mine was uncovered. As it is, between the essential risks of a speculation, such as a mine always is, and the probability of buying at an inflated valuation, the average member of the public is likely to get off on the wrong foot. If the 'big houses,' or financial corporations controlling mines, such as those of the Rand, were to keep their shareholders, and through them the public, faithfully informed concerning the true conditions governing the profitable productivity of their operations, in other words, if directors would act like trustees, then the chances of making money out of mining would be increased for the shareholders or the public and decreased for the clever—or 'slim' as they call them in South Africa—financiers. On the other hand, 'the possibility of financial loss' would deter the State from making many a reasonable venture. That possibility of loss is inherent in mining, because mining is essentially venturesome. We do not expect to remove that essential quality, for it is one that pertains to a business that is as risky as it may be profitable. On the Rand, unfortunately, the risk is too much one way. A mine may do less than is expected of it, but it is unlikely to do more. That is the drawback to the 'sure thing' in mining. In ordinary vein mining, with possibilities in depth and the probability of discovering new ore-bodies, or even a big bonanza, in the course of intelligent exploratory work, there is the chance of a pleasant surprise. On the whole, it is not good business to buy ore in reserve; the best fun in mining is in the sport of finding ore and in the opportunity to strike it so rich that tables of amortization assume an academic aspect. The State is too old and too timid to enjoy that game; it is the privilege of the true adventurer, of him that is willing to put all to the touch and penetrate into the unknown.

The Greatest Gold Mine

Nine years ago, in May 1907, when passing in review the leading gold-producing mines of the world, we came to the conclusion that the three best mines were the Robinson, the Waihi, and the Homestake. The Robinson was at that time the premier property on the Rand gold-field; it had 4,500,000 tons of \$14 ore assured and was being operated at a cost of \$4.90 per ton. The stoping width was 6½ feet and only 18% of waste had to be sorted out of the mine product. Finally, the mine was earning \$3,500,000 per annum. This, it will be granted, was a handsome showing. What has happened since then? In 1915 the mill treated 688,800 tons of 6.72 dwt. ore at a cost of \$3.40, after sorting out only 3.7%. The yield in gold was worth \$1,652,389 (£1 being taken at \$4.85) of which \$2378,692 was labeled profit. The dividend was \$1,915,750. Nine years ago the mine had paid \$25,197,362 on a capital of \$13,750,000. Since then it has produced 5,280,460 tons yielding \$55,069,060, av-

eraging \$10.43 per ton. On this a nominal profit of \$35,373,194 was declared and \$28,738,263 distributed in dividends, equal to 24% per annum during the nine years, on a capital of £2,750,000 or \$13,337,500. Evidently therefore the Robinson has fulfilled expectations. From the beginning of 1888 to the end of 1915, this mine has produced £20,480,945, equal to \$99,332,584, from 7,966,775 tons of ore, averaging \$12.50 per ton, at a cost of \$4.43 per ton. The dividends aggregate 405½%, or \$54,235,625, in 27 years, or 15% per annum on the 550,000 shares of £5 each. Incidentally, the aggregate 'profit' is just about \$10,000,000 less than the total of dividends. During the first year, 1888, the ore averaged 3 oz. gold per ton; just before the Boer War, in 1899, the average was 17 dwt.; and in 1912, when the richest layer of banket, the Leader, was approaching exhaustion, the average fell to 10½ dwt. per ton. In the 27 years the cost decreased from \$14.45 to \$3.40. Now there remains 565,100 tons of about 10 dwt. ore in the Leader and South Reef, besides 400,000 tons of 4.4 dwt. stuff in the

owning the ground ahead of it on the dip, so that it possessed chances of further discovery in depth—and the risk of disappointment. The Robinson, so it seemed to the present writer nine years ago, was "more nearly an investment, while the Waihi"—we said—"is a most attractive speculation." To this we added: "As all experience proves that persistence in depth is hazardous and as the bottom of the Robinson's ore measures are known and those of the Waihi are unknown, the choice is between the assured and the possible, where both are sumptuous. We accept the responsibility and label the Robinson the greatest gold mine in the world." The choice between the two great mines has proved correct. The Waihi did have bad luck in depth, and this bad luck, being accompanied by over-valuation of the shares and delay in making known the fact of impoverishment on the lower levels, caused a fiasco of a sensational and disastrous character. The quotation on 500,000 shares dropped from \$50 to \$14.50 within twelve months and is now at \$8.50, indicating a fall of \$20,212,750 in the market valuation. The episode reflects discredit on the directors in London; for either they were ignorant concerning facts that were known at the mine or they were aware of the truth and failed to advise the shareholders with reasonable promptitude. The Waihi must have caused a great loss of money to the public, as always happens when rich mines are wildly over-valued. In 1915 the mine produced 192,333 tons yielding \$1,689,230, of which \$753,724 was profit and \$481,000 was dividend, this being at the rate of 20%, so that on its original capital of £500,000 the mine is still doing respectably. But the



Main Reef. This includes packs, pillars, and remnants of ground. Thus the mine has enough ore to extend its life into the middle of 1917, by which time it will have produced over \$100,000,000 in gold. Then it will be definitely finished, for the property has been completely 'developed,' that is, all the area vertically under the claims has been explored and will be exhausted. By the laws of the Transvaal there is no extra-lateral right to mine on the dip beyond the side-line, the lode in the Robinson having been already mined on its dip by the Robinson Deep, which as a 'deep level' has proved a worthy second to its corresponding 'outcrop' property. So the Robinson has made good; it does honor to its successive managers, the late Capt. Thomas Mein, his son Mr. William W. Mein, and the present manager, Mr. Palmer Carter.

Discussing the relative merits of the Robinson and the Waihi in 1907, we emphasized the fact that the resources of the Robinson were known accurately, because not only was it well explored and sampled, but the workings of the mine below it on the dip had tested the deepest ground that it had the right to work. The Robinson had no possibilities in depth, but it also lacked the chances of sudden impoverishment. On the other hand, the Waihi, with reserves only a quarter those of the Robinson, had the right to follow the lode indefinitely in depth,

owning the ground ahead of it on the dip, so that it possessed chances of further discovery in depth—and the risk of disappointment. The Robinson, so it seemed to the present writer nine years ago, was "more nearly an investment, while the Waihi"—we said—"is a most attractive speculation." To this we added: "As all experience proves that persistence in depth is hazardous and as the bottom of the Robinson's ore measures are known and those of the Waihi are unknown, the choice is between the assured and the possible, where both are sumptuous. We accept the responsibility and label the Robinson the greatest gold mine in the world." The choice between the two great mines has proved correct. The Waihi did have bad luck in depth, and this bad luck, being accompanied by over-valuation of the shares and delay in making known the fact of impoverishment on the lower levels, caused a fiasco of a sensational and disastrous character. The quotation on 500,000 shares dropped from \$50 to \$14.50 within twelve months and is now at \$8.50, indicating a fall of \$20,212,750 in the market valuation. The episode reflects discredit on the directors in London; for either they were ignorant concerning facts that were known at the mine or they were aware of the truth and failed to advise the shareholders with reasonable promptitude. The Waihi must have caused a great loss of money to the public, as always happens when rich mines are wildly over-valued. In 1915 the mine produced 192,333 tons yielding \$1,689,230, of which \$753,724 was profit and \$481,000 was dividend, this being at the rate of 20%, so that on its original capital of £500,000 the mine is still doing respectably. But the shareholders who bought at \$50 per share will hardly be satisfied with a 2% return on a venture now known to be hazardous. The reserve of ore is estimated at 806,000 tons, besides 673,900 tons in pillars and remnants. The mine is now 1470 feet deep.

In 1907 we stated that the reserves of the Homestake were not known, but they were supposed to be "sufficient for at least twenty years, that is, over 30,000,000 tons." Dividends of \$22,134,840 had been paid up to then, which was 30 years after the company started to work. The workings were 1400 feet deep, but stoping had been extended only to 1000 feet. The low grade of the ore, \$3.85 per ton, and the small margin of profit over the cost, which was \$2.73, was a factor of danger and caused us to prefer the Robinson and the Waihi. During the nine years since that was written, the margin over cost has been widened, the yield last year having been \$4.08 and the cost \$2.65. In the interval the mine has yielded \$53,771,793 out of which \$14,046,840 has been paid in dividends. To the end of 1915 the Homestake Mining Company, which was incorporated on November 5, 1877, by J. B. Haggin, George Hearst, and Lloyd Tevis, had produced \$140,610,382 in gold, from which \$35,615,908 had been distributed in dividends to the shareholders. In the year 1915 the output was 1,573,822 tons, averaging \$4.08, at a cost of \$2.65 per ton. The production of

ore has been increased 10,000 tons per month since 1907, so that the gross output has been augmented by about \$1,500,000 and the dividends by \$1,000,000 per annum. In 1914 Mr. Richard Blackstone succeeded the late Thomas J. Grier as manager. During later years the technical policy appears to have become more progressive. What reserves of ore the mine may have is not known. It is reputed to have enough for 30 years, but the only official information available is the statement by the manager appearing in the last annual report informing

the principal gold-bearing member of the series is the Main Reef Leader, an extremely persistent bed of conglomerate, which in the Brakpan mine averages 6.7 dwt. gold per ton; in the New Modderfontein, 8.2; in the Modderfontein B, 8.6; in the Government Areas, 6.5; and in the Springs mine, 10.5, so far as determined, for a stoping-width of about 5 feet. In this part of the district the dip of the strata and the included ore ranges between 8° and 22°.

The New Modderfontein and Modderfontein B are contiguous outcrop mines, with the Van Ryn Deep, the Modderfontein Deep, and Government Areas as their corresponding 'deep-levels.' The New Modderfontein property includes 1265 claims, or 1860 acres, of ore-bearing ground. The purchase entailed sums aggregating \$2,454,325, a part of the consideration being an annuity of \$8,950 for 20 years. The company was organized in 1888 and started milling with 10 stamps four years later. In 1896 a new 60-stamp mill was built and by 1909 the number of stamps had been increased to 180, assisted by seven tube-mills. A second mill is now being erected, so as to bring the crushing capacity to 90,000 tons per month. During the year ended June 30, 1915, the mine produced 738,300 tons, of which 17% was removed as waste, leaving 611,800 tons for the mill, where 184,208 ounces of gold was extracted by amalgamation and 94,678 ounces by cyanidation, the total gold being worth \$5,616,324, equivalent to \$9.18 per ton. The working cost was \$3.82 per ton, so that the profit was \$3,314,738, from which dividends amounting to \$2,121,875 were paid, equivalent to 31 1/4% on a capital of 350,000 shares of £4 each. The development and equipment of the mine has involved an outlay of \$6,937,921. Henceforth all such expenditures will come out of revenue account. The ore already proved is estimated at 6,000,000 tons, averaging 8.15 dwt. per ton, besides 1,000,000 tons of 'partly developed' ore. But this does not begin to measure the resources of the mine. Possibilities become strong probabilities in the light of evidence obtainable from the workings of the adjacent property—the Modderfontein B—and from workings deeper on the dip in the Modderfontein Deep and Van Ryn Deep mines. In June last year 169 claims out of the 1265 had been worked out, yielding 31,940 tons per claim, so that the possibilities of further production are enormous. Deducting 20% for faulted areas, 15% for sorting, and allowing a net stoping width of 48 inches, the ground remaining should yield 19,000,000 tons. Crushing at the rate of a million tons per annum, the life of the mine should last about 20 years and it should produce \$125,000,000 more. From June 1895 to June 1915, exactly 20 years, the New Modderfontein has produced 1,816,680 tons, yielding 1,950,553 ounces of gold, worth \$3,745,076, of which \$17,860,023 has been 'net profit' and \$12,247,250 dividends. The shares are quoted at \$82.50. This is today, we believe, the greatest gold mine in the world, as measured in known resources and assured profits.



the shareholders that "the measured ore reserves are large and sufficient to supply the reduction plants for many years." About 2,000,000 tons of ore is said to be stored underground. In default of the essential information concerning the resources of the property, it cannot be appraised nor can it be compared with other great mines. But whatever it may accomplish in the future, the Homestake has already established its position as the most persistently profitable low grade gold mine ever exploited by man.

Since 1907 a group of big and highly productive mines has been developed in the eastern end of the Rand or Witwatersrand, to give the goldfield its proper name. In that locality the Main Reef Series, as the gold-bearing beds of conglomerate are called, has a dip flatter than in the Central Rand, where are, for example, the Robinson, Simmer & Jack, and Village Main Reef, mentioned in this or in a preceding article. In the Far East Rand

A Journey to British Columbia

By T. A. Rickard

This will be a non-technical article, so I warn my readers that they may find nothing of immediate use to them, but if they care to see something of the human side of a beautiful mining region they can sail with me on the steamship *Governor* from San Francisco to Victoria, the capital of British Columbia.

The approach to any country from the sea is more impressive than the entry overland. Railways take the traveler through intermediate stretches of transition and usually bring him to his destination through the bedraggled outskirts of big cities, but to the voyager by sea is given all the charm of the unexpected: after a few days of monotony on the trackless waters he sees a new land on the horizon; he glides into a beautiful harbor—for all harbors are lovely to the seafarer; he enters a strange city through its water-gate, which is always romantic; finally he lands in a community so unlike the one he has left that it seems as if he had discovered a new world. Such are the ideas that would be uppermost in the mind of any observant man or woman from California on arrival at Victoria. The distance is only 740 miles and the time spent on the voyage is only 50 hours, yet the change of scene, of climate, of people, is vivid. On landing one hears the official language of the United States spoken with strange accents, one sees the British policeman—the ‘bobby’—at the street corners, and the martial Highlander swings past in his kilt. There are more horses on the streets than in San Francisco, there are more men in khaki, and in the stores (or ‘shops’) one receives a ‘Thank you’ with unexpected frequency.

The harbor reaches to the heart of the city. There the imposing Parliament buildings and the handsome hostelry of the C. P. R. (nobody says ‘Canadian Pacific Railway’) are surrounded by lawns of vivid green, for rain is almost as frequent as in England, and to one leaving California in the dry months the season seems much behind. The population of Victoria is only 48,000; it can claim no importance as a commercial centre, but it is a delightful place of residence, and of homes, with Government House, the seat of the Lieutenant-Governor, as the social nucleus.

It was a sunny day when we (not the editorial but the domestic ‘we,’ for my much better half was with me) landed. A stroll along the main thoroughfare—Government street—suggested business depression, in part the sequel to a ‘busted’ real-estate boom but in large measure due to the preoccupation of war. Returning, the view was fine: on the right the harbor with its shipping, on the left the Empress hotel, in front the ornate pile of the Parliament buildings, and beyond them the snow-capped summits of the Olympic range, on the United States mainland, across the strait of Juan de Fuca.

Anybody interested in mining goes, on arrival at Victoria, to see Mr. William Fleet Robertson, the Provincial Mineralogist, who will be found rich with information and generous in the giving of it. The position he holds is more important than that of State Mineralogist on our side of the line because it is non-political and is therefore held by a good man for a long term of years. Mr. Robertson’s predecessor was Mr. William A. Carlyle, (McGill, class of ’87) afterward manager at Rio Tinto, later professor of metallurgy in the Royal School of Mines, London. But Mr. Robertson has held the post since 1898, so that he has his own background. A graduate of McGill University, in the class of ’80, he obtained his first professional experience with the Orford Copper Company and then served as superintendent for that great Canadian, James Douglas, at the Phoenixville copper plant in Pennsylvania. There the Hunt & Douglas process, a metallurgical landmark, was tried, soon to be replaced by the smelting and refining of Western matte, for the early leaching processes proved too expensive, faring ill when compared with the electrolytic methods evolved in these later days of cheap electricity. In 1881 the Orford company leased the Phoenixville plant before building the more celebrated smelter at Constable Hook, much to the annoyance of the good people on Staten Island, New York. Henry M. Howe, the authority on ferrous metallurgy, was manager and Mr. Robertson was superintendent. It was in 1880 at Capelton, in Quebec, that Professor Howe got his idea for the ‘large blast-furnace,’ as it was then called. The Orford people had leased the Capelton plant from an old Scottish company, which had erected a row of copper blast-furnaces, 4 by 4 ft. inside. In the course of operations a copper bottom rich in gold had accumulated in two adjacent furnaces. By the terms of the lease, it was not permissible to tear down anything, whereupon Howe walled the space between these two furnaces, making one 15 ft. long. The ground sloped so that a low tap-hole could be used in the new wall. This enlargement proved so successful that the Orford works at Eustis (a mile from Capelton) started with furnaces 4 by 11 ft. inside. This development was the kind of ‘accident’ that befalls a resourceful man; it was the forerunner of the much bigger blast-furnaces, also composite, built by E. P. Mathewson (McGill, class of ’85) at Anaconda. Besides these metallurgical reminiscences Mr. Robertson gave me an outline of the conditions governing the mining industry of the Province. The past year had shown a gratifying increase in the production of metals, ascribed not so much to fresh discoveries as to the expansion of established enterprises. A further increase in the output was assured, he said, for 1916, in conse-

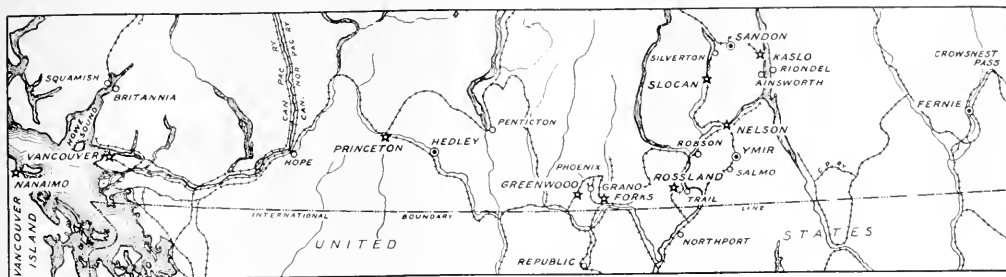
quence of the rush to obtain the benefit of high prices for metals.

Next day, in the afternoon, we sailed on the *Princess Charlotte* for Vancouver, a voyage of 80 miles accomplished in 4½ hours. The steamer threads her way among fir-clad islands, passing through the narrows of Active pass, before crossing the broader expanse of the inland sea, called Gulf of Georgia, that separates Vancouver island from the mainland, to which the city of Vancouver is the Canadian port of entry. This city stands, not on the estuary of the Fraser river, as might be inferred, but on an inlet or 'sound,' resembling those of New Zealand or a Norwegian fiord. On the right—which is south—is a richly wooded peninsula; on the left is the dark mass of the Cascade range, half-veiled in mist. The steamer makes for the Point Atkinson lighthouse and then turns abruptly to the right into Burrard inlet, the harbor of Vancouver, which, with its jagged sky-line of tall buildings, looks like a miniature New York set amid primeval woods and lordly mountains. Here also the traveler rests at a C. P. R. hotel, 'The Vancouver,' which in style and character suits its surroundings just as 'The Empress' appears fitted to Victoria. The architecture and interior of the Vancouver hotel suggest that it was built to please a committee of real-estate agents during a boom; it is pretentious in proportion, florid in decoration, and bustling in business; a swarm of Japanese 'boys' give it an Oriental touch; you find many more Americans, drummers, tourists, capitalists, and engineers, here than at Victoria. Two years ago Vancouver had a population of 125,000; since then the boom has collapsed, so that the population is about 100,000, but it remains a busy place, and a great port.

After a day of reconnaissance we took the train for that important smelting centre, Trail. The C. P. R. track crosses the peninsula from Burrard inlet, on the south shore of which Vancouver is situated, to the west bank of the Fraser river, which here flows nearly due south. A big, but turbulent, stream it is. Scenery on a big scale is everywhere to be enjoyed. For the most part, British Columbia is a mountain land richly forested, cleft by big rivers and jewelled with long lakes that follow lines of glacial erosion. Leaving Vancouver the railroad passes through clearings, bordering the river, on which fruit and grain are cultivated profitably. At Agassiz is a large experimental farm, which furnishes much practical information to the new settlers. In a country so sparsely populated it surprises one to see another railway grade on the opposite bank of the river. That is the Canadian Northern railway, built by those great hypnotizers Mackenzie & Mann, contractors, both of whom have now a prefix, for both have been knighted, the one being Sir William and the other Sir Donald. They floated bonds on the strength of the anticipated wheat haulage from the grain fields of Alberta and Saskatchewan to Vancouver. Incidentally it is to be remarked that the pioneers of exploration and of railway development in Canada were mostly Scots. The first transcontinental railway owed its origin mainly to the indomitable pluck and foreseeing initiative of Donald

A. Smith (Lord Strathcona) and George Stephen (Lord Mt. Stephen). The Fraser river was first explored by Simon Fraser, an officer of the North-West Fur Company, in 1806. He thought it was the Columbia, but later he followed it to the sea, and for this the river was named after him. In 1857 the finding of gold on the Fraser started the first big rush into British Columbia. In 1859 two parties from Eastern Canada came overland by way of the Yellow Head pass. The lower reaches of the Fraser are no longer important as placer diggings, but millions of dollars were won from Boston bar, a few miles below Yale, and when the water is low the patient Mongol is yet to be seen gleaning gold from the shelving sand. The Fraser yielded its richest treasure nearer its source, at Barkerville, in the Cariboo district. In the early days stern-wheel steamers plied as far up-stream as Yale and the road to the upper diggings crossed the Fraser at Spuzzam, going thence to Barkerville.

Night drew the curtains on the scenery. We awoke at Revelstoke, where passengers for the West Kootenay country take another train, which brings them, in 27½ miles, to the head of Arrow lakes, expansions of the Columbia river, a linked water-way on which they voyage for 130 miles in a stern-wheel steamer for the whole of a long day, arriving at Robson in the evening. This lake-travel is a marked feature of transport in British Columbia; it is pleasant and picturesque. The last time I had made the same journey was with a client, the late Ralph Baggaley, in 1901, when we had as fellow-passenger a solitary soldier returning from the Boer war. He had left his little ranch on the lake and gone 13,000 miles to fight for his country; he had done his duty, and returned to his log-house and its patch of cultivation, disembarking from the steamer on a lonely wharf, where no one came to greet him, no one gave him a hand. To me he seemed truly heroic, a noble citizen, a man who had done his duty quietly and thoroughly. This time, going southward from Arrowhead, we had 90 khaki-clad soldiers on their way from the camp at Vernon to their homes, during a brief holiday from training. They too had volunteered for service on a distant battlefield. A sturdy set of fellows they looked—vigorous and alert. In the morning paper I read a speech by the Premier of the Province, Mr. W. J. Bowser, in which he stated that one out of every 13 in the population—men, women, and children—of British Columbia had volunteered for service with the Allies in Europe. During the days spent in the Province I obtained plenty of evidence of the wonderful loyalty of the people to their home-land and to a cause they have truly at heart. Of the surveyors 107 out of 260 on the register have gone to the front, and of the remainder the majority are too old or physically unfit to go; at the Blue Bell mine, where 85 men are on the pay-roll, no less than 27 had gone to the front; at the Hedley mine, 41 out of 150 had volunteered; and returning from Howe Sound on a little steamer the captain told me that 23 out of 60 in the company's employ had enlisted. At every mine in British Columbia each employee, from manager



MAP OF SOUTHERN BRITISH COLUMBIA, SHOWING THE BOUNDARY REGION.

to roustabout, voluntarily contributes one day's pay or more per month to the Patriotic Fund, which is intended for the benefit of the dependents of the soldiers. Many of the technical men and superintendents are Americans, but they also 'chip in' with pleasure. Incidentally, I found many Americans that had become naturalized; it seems easier for an American to become a Canadian than to become a Britisher; but that is not surprising, for the Canadian idea readily fuses the American ideal with the British tradition.

At Trail we remained for three days, appreciating diverse metallurgical operations, while enjoying the hospitality, mental and physical, of Mr. and Mrs. E. H. Hamilton. Our host was another McGill graduate (class of '84). This Canadian university has produced a number of notable metallurgists: Mathewson, Carlyle, and Robertson have been mentioned. The Hamilton brothers constitute a noteworthy trio, E. H. at Trail, A. McL. at Aguascalientes, and W. J. at Cerro de Pasco. Later I shall go into the details of the electrolytic practice at Trail. This smelter was built originally to treat the output of Rossland, which still supplies 1000 tons out of the 1600 treated daily. The plant overlooks the Columbia river, which flows southward around the mountain constituting the Rossland mining district. Only six miles away, on the American side of the boundary line, is the Northport smelter, now operated by Harry L. Day of Spokane, the owner of the Hercules and other silver-lead mines in the Coeur d'Alene. The Trail smelter was built by that splendid adventurer, F. Augustus Heinze, but it is now controlled by a financial group identified with the C. P. R. A clever staff of technical men is in charge and good work is being done. It is the only metal refinery in Canada, and is playing a decisive part in the development of the Boundary region—a name given to that part of British Columbia adjacent to the international line, which is the latitude of 49° north.

Everybody goes to Nelson, the principal town in the Kootenay region. It was an important mining centre 15 years ago and continues to be the chief place of residence, being the terminus or division point of the C. P. R., Kettle Valley, and Great Northern railways. Situated on the mountain-side above the west arm of Lake Kootenay, it has a charming site and a lovely outlook. Here we were met by an old friend, S. S. Fowler (Columbia '84), who took us in a motor-launch to Riondel, 30 miles

distant, on the main lake. In this part of the world everybody uses the motor-launch, it is the gondola of the mountains. We arrived at dark, having enjoyed the long twilight of this northern latitude and watched the day fade behind the dark forest-clad mountains. Concerning the Blue Bell mine and mill, of which Mr. Fowler is manager, I shall have something to say in a later article. The mine is situated on a peninsula from the summit of which the traveler gains a fine view of the lake, up and down. Here the lake is 2½ miles wide; on the opposite side are the mountains that separate it from the Slocan lakes, which fill narrow valleys between off-shoots of the Selkirk range. Riondel looks across the lake to Ainsworth, where are several silver-lead mines. The picture is framed by the tall columns of the Douglas fir, a species characteristic of the Pacific slope of the Northwest. This noble tree is also known as the Oregon pine; it is the *pseudotsuga Douglasii* or false hemlock, both unpleasant names. But it is a handsome tree and adds greatly to the beauty of the British Columbian landscape.

Looking across the lake one can see the few houses that constitute the settlement of Ainsworth and the lines of clearing that indicate the course of various tramways from the mines on the mountain-side to the shore below. Dumps dot the forested slope. Southward, toward Balfour, are the scattered rock-piles of the Highlander group, now idle; behind them, but not visible, lie the United and other claims now being developed by A. W. McCune, of Salt Lake, who is driving a long adit to tap the expected continuation of a silver-lead orebody. North of Ainsworth, high on the mountain, is the No. 1 mine, belonging to the Consolidated Mining & Smelting Company and yielding a silver ore, poor in lead, for the smelter at Trail. Near-by is the Silver Hoard, owned by Spokane people. These two mines mark replacements in limestone, while the United is a fissure crossing the schist and limestone. The No. 1 has a tramway to the lake-shore. Farther north is the Highlander connected by tram with a concentrating mill at the water-side, where Cedar creek enters the lake. This also belongs to the Consolidated and yields a silver-lead ore. Beyond the Highlander, farther north, are the Florence and other properties controlled at Spokane. The Florence is building a concentrator in a clearing close to the shore. There is talk of a 300-ton plant, using flotation. The

Ainsworth district is said to be fairly prosperous and is likely to become more productive, the current development work being well planned. Reciting the various ownerships one is reminded of the large part played by Spokane operators in the exploitation of the Boundary and Kootenay mining districts. Most of these energetic Americans began their British Columbian experience at Rossland, where several of them made much money. Patsy Clark, John A. Finch, A. B. Campbell, Charles Sweeney, and John R. Cook were the leaders, for most of them have gone over the last range. Mr. Cook and Col. Payton continue the tradition. Such names as Yankee Girl, Mollie Gibson, New Denver, and Silverton suggest the number of miners from Colorado that helped to prospect the Kootenay districts. Indeed, the friendly co-operation between Canadians and Americans is a part of the history of British Columbian mining.

After a memorable glimpse of home life in this lovely wilderness, we returned in the motor-launch, 12 miles to Balfour, where we caught the steamer plying between Kootenay Landing and Nelson. The scenery is well remembered. Terraced lines along the mountainsides mark the escarpments or edges of bedded rocks. Variation of foliage is due largely to forest-fires of different periods. The mountains are clad in foliage to their very summits, save those that reach perpetual snow. The dark silhouette of the ranges provokes the imagination with questions of the beyond. Along the shore of the lake a white rim is made by high-water washing the rock, which is fringed with bleached drift-wood. Inlets are bordered with sandy beaches, but elsewhere the cliff plunges at a high angle into deep water. A great stillness broods over these long and narrow lakes; man's trespass is relatively inconsequent; the purring of a motor-boat or the pulsating splash of a steamer is heard at rare intervals, but the birds are few and the smoke of human industry does not stain the blue of a tranquil sky.

Between Nelson and Grand Forks one receives a reminder of British Columbia's great asset in water-power, for at Bonnington falls the Kootenay river leaps and runs in joyous strength. Enormous reserves of power for developing electric energy are plainly available. The traveler also hears about the Donkadors, the Russian peasants occupying farms along the big river that becomes the Columbia and along the Grand Forks valley, which is watered by the Kettle, another tributary of the Columbia. The Donkadors live under the patriarchal system, their chief being Peter Veregin, a man of unusual ability. About 8000 of these Russians have settled in British Columbia, on a suggestion made by the son of Henry George to the son of Leo Tolstoy. The Donkadors refused to serve in the Russian army, being opposed to the killing of any living thing, even fish. They are vegetarians, and at first would not employ horses for pulling the plough delegating that task to their women. Now they use horses, but the women and children constitute an important part of the field labor. They are hard workers and intense cultivators. From the train one can see the stereotyped dwellings of this community, two brick houses connected at the rear by a

longer dwelling, this being set aside for the unmarried while the wings in front are occupied by the married folk. At Robson the Donkadors have built a handsome concrete bridge and near-by is their jam factory, the products of which are highly extolled. While orderly, they refuse to keep vital statistics and will not permit their children to go to school. The Provincial Government has humored them, but not without a few quarrels with the local authorities. If employed off their farms they go in groups, not as individuals, and payment for their work is made to the patriarch. How desirable they are as an element in the population of the Province is a matter of dispute. To me they seemed a gain, for they are quiet, industrious, and productive. Some of them have broken away from the organization and have started farms on individual account. In course of time they will learn to speak English, they will see the advantages of sending their children to school, intermarriages will ensue, and a few decades hence the manner of their coming will be a tradition. Like the Boers and the Mormons they will be engulfed in the tide of life around them.

From Nelson we returned to the Coast over the Kettle Valley railroad, a line that runs near the boundary and serves as a chord to the arc made by the route from Vancouver to Nelson by way of Revelstoke and the Arrow lakes. The line as a whole had only just been opened to passenger traffic. It serves the Boundary region, passing through such mining centres as Grand Forks, Greenwood, and Princeton. Leaving Robson the railway runs along the precipitous mountain slope above the lower Arrow lake (or Columbia river) and then turns westward among the fir-woods overlooking Lake Christina. But the best scenery is east of Penticton, the town at the south end of Lake Okanagan. The railroad makes two great horse-shoe curves above the Kelowna valley. Kelowna means 'the bear,' the valley being named after an old settler whose grizzly beard caused the Indians to liken him to a denizen of the adjacent woods.

But it is of the view from the high-line railroad that I wish to speak. In the twilight we made the turn that unwound the panoramic film of wonderland. The foreground of rocks and firs descends into the vague vastness of a far-spreading valley, varied by patches of cultivation, dimly discernible in the fading light; it is a continental topography in miniature, little ranges of hills and scattered surfaces of water, beginning to reflect the afterglow; on the farther edge of this broad valley there is a series of linked lakes whose ruffled silver alternates with still water reflecting the dark slopes of the onlooking mountains—a big range of flat-topped summits, suggesting remnants of a great plateau, sharply silhouetted against a saffron sky. No sign of man appears save the level scar of the railroad grade cutting the forested slope, but a big black bird, like the spirit of evil, crosses the sunset and vanishes into the woods. Fainter grows the light. To the north the blue hills of Okanagan fade into the purple distance, the sound of a water-fall fulfills the sense, and the twilight merges into a starry night.

Soon the lights of Penticton appeared, the train ran



THE HARBOR OF VICTORIA AS SEEN FROM THE EMPRESS HOTEL.



YALE, B. C. THE FRASER RIVER AND THE CANADIAN PACIFIC RAILROAD.

down to the water-side, where the brilliantly illuminated lake-steamer was waiting to discharge and to receive passengers, while on the shore, behind an avenue of handsome trees, the lights of the Inco hotel welcomed the weary traveler. At Penttieton Mr. Gomer P. Jones, manager of the Nickel Plate mine, met us with his car, in which we motored to Hedley. The road was in excellent condition, for it had been swept clear of stones in honor of the Premier (Mr. W. J. Bowser) recently on a pre-election tour of the Province. At Olalla, 26 miles from Penttieton, we crossed the trail of a punctured boom. Ten years ago this locality boomed large in the daily press, the Sunday issues of the *World* and *Journal* in New York published full-page pictures of the supposed mines, also of an imaginary race-course, smelter, and town, as well as of trains running on an imaginary railroad, all of which, as Mr. James W. Gerard, now at Berlin, would say, "originated in the fertile imagination of the boosters." Yet there was some fire to this smoke, for the Dolphin, the prospect that gave some color to the boom, is now shipping copper ore to the smelter at Grand Forks and numerous promising showings of ore are said to exist. Near Keremeos, six miles south, is the Horn Silver, a new mining enterprise that is shipping high-grade silver ore, also to Grand Forks, where is the smelter of the Granby Consolidated company. From Keremeos it is 18 miles to Hedley, up the valley of the Similkameen. The first sign of industry is the flume and power-house; then the Striped mountain, so named by Dawson, introduces the characteristic geology of the district—a series of limestone beds intercalated by sheets of eruptive rock.

The mine is 3700 ft. above the mill. It was a hot day—August 26—when I made my visit to the upper workings. In the No. 3 adit the ice of winter lingered, the door of the "tunnel" being kept closed so that the ice might be conserved for use in the boarding-house. The temperature was 40° F. On the porch of the storehouse it was 80° and at the mill it was 95°. Descending by the tramway, the air became sensibly hotter and during the last thousand feet of descent it seemed like the approach to Tophet. Concerning the geology and ore deposits I shall write separately. From the upper terminal of the tramway, one obtains a fine view of the region, the Boundary country, as it is called, for the international line is only 30 miles south. Incidentally, it may be remarked that if the line had been drawn one degree farther north, that is, the parallel of 50°, it would have excluded several rich Canadian mining districts, while if it had been placed one degree southward the extension would have included little valuable mineral territory, save Republic and a few prospects in the Cascades. Where we stood, at the head of the tramway, our western horizon was bounded by the Hope mountains, on the near side of the Fraser river. South-west the white summit of Mt. Baker stood sentinel. At our feet the winding valley of the Similkameen river lost itself in the maze of the Cascade range, westward, for its source is in the United States, while the chief tributary, the Tulameen, which starts in the Hope mountains, joins it at

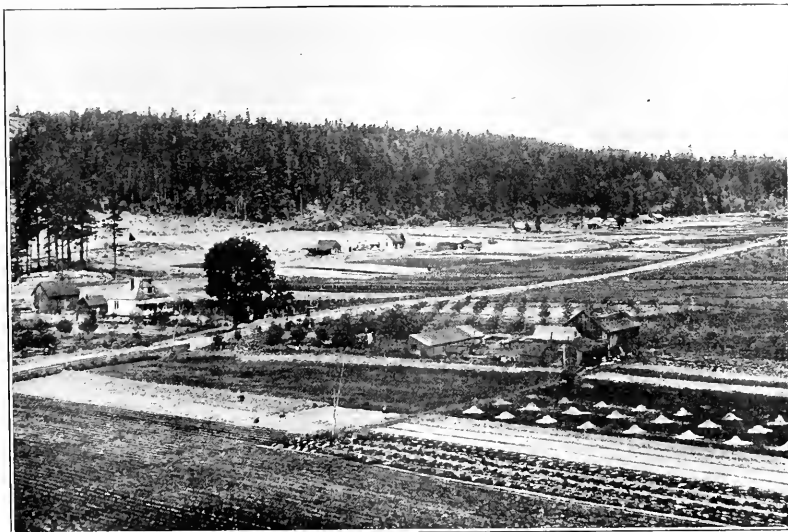
Princeton. This is a promising mining district and is attracting attention just now.

In order to catch the train at Princeton, we had to motor thither between midnight and 1:40 a.m. To kill time Mr. Jones took us to the moving-picture show. While there the electric lights flickered three times, this being a signal, so I was told, that something was wrong at the power-plant. None of us guessed the cause of it, but when we emerged from the 'movie' hall, the sky was glorified with the *aurora borealis* or northern lights. The spectral streamers thrown to the zenith looked like ribbons of luminous gas issuing from a furnace beyond the dark rim of the northern mountains. The last time I had seen a good display of this magnetic phenomenon was at Rat Portage (now Kenora) in Manitoba in June 1897; while farther north, in the Yukon and Alaska, I was not so fortunate. The idea used to prevail that the aurora was caused by electrical discharges in a frosty atmosphere, that is, one containing multitudinous particles of ice, but recent scientific observation gives another and more satisfactory theory: "that electrified particles, shot out from the sun with great velocity, are drawn to the earth's magnetic poles along the lines of force. Striking the rarified gases of the upper atmosphere, they illuminate them, just as the electric discharge lights up a vacuum-tube."* The lowest height above the earth's surface at which the aurora has been observed is 25 miles, at which level the electrons from the sun would penetrate a nitrogen atmosphere, while at a height of 60 miles the atmosphere consists largely of rarified hydrogen. When sun-spots are numerous, the discharge of electrons is most violent and the most brilliant auroras are observed, but the night-sky is always illuminated in some degree owing to the penetration of the earth's atmosphere by these solar emanations. On the evening mentioned—August 26—the electricians were perplexed by the irregular behavior of their apparatus and we learned next day that telegraphic communication was interrupted for a period of 20 minutes while the earth was being bombarded by solar ions.

Leaving Vancouver at 9:15 a.m. on August 28 by the S. S. *Bellona*, I arrived at Britannia Beach at 12:30. The distance is only 28 miles, but the steamer makes several calls, two of them at different points on Bowen island, a holiday resort, where camping parties depend upon this vessel for mail and supplies. Bowen island is 14 miles from Vancouver, at the entrance to Howe sound, near the head of which is Britannia Beach.

The forest fires near Bellingham, in Washington, had blown smoke across the international boundary so as to make a murky atmosphere, through which the Cascade range loomed with magnified impressiveness. Emerging from Burrard inlet, on which Vancouver stands, and going around the Point Atkinson promontory into Howe sound, the traveler sees a railroad grade on which no trains are running. This extends from North Vancouver

*Birkeland's and Störmer's theory as stated by Ira Remsen before the National Academy of Sciences, at Washington, on April 22, 1913.



FARMS IN THE ENVIRONS OF VICTORIA, B. C.



THE QUARRY-GARDEN OF THE CEMENT WORKS, VICTORIA.

to Horeshoe bay, 9 miles, and will connect eventually with the Pacific Great Eastern railroad now running 120 miles from Squamish, at the head of Howe sound, to Lillooet, and 47 miles farther to railhead at Clinton, traversing a mining region of some promise, notably around Pemberton. The line is planned to reach Prince George, on the Grand Trunk Pacific. This part of British Columbia is the scene of railroad schemes that anticipate a traffic of continental proportions; indeed, much of this activity is founded on the expectation that the grain trade of the prairie provinces east of the Rocky mountains must find an outlet westward.

Entering Howe sound, the bluster outside gives place to quiet water and a summer air. Near Anvil island the scenery becomes Norwegian in its boldness. Snow-capped peaks overlook the inlet and steep forested slopes enclose it. As the little vessel ploughs her way through waters in which high mountains are reflected there comes that recurrent feeling that we are adventurers entering the unknown, voyagers with Vancouver or Wrangel into a new world. Headland after headland projects forward in fine perspective. The steamer turns a point, runs into a pretty bay, enclosed by cliffs above which the forest rises, tier on tier, up to the snow. This is Porteau, where a plant for exploiting the gravel and rock used by contractors in Vancouver is situated. Five miles more and the houses on the beach at Britannia emerge from the haze, along a wide bay indenting the eastern shore at a point six miles from the head of the sound. First the red roof of the old vamper-building appears, then the green roof of the big department-store, and finally the terraced building of the new mill and the reddish cutting of the tramway, with the ordered array of houses constituting the settlement tributary to this important copper mine. Concerning the mine and mill, I shall have a good deal to say in another and more technical article. I spent a couple of deeply interesting days at Britannia, returning late in the evening of August 29. By courtesy of an introduction to the captain, I was permitted to sit in the pilot-house, a position from which the charm of the scenery was intensified by detachment from the other passengers. It was interesting to watch the navigation. The flare of the Atkinson light was seen on the clouds long before the direct rays were visible and I noticed that when within the glare from the lighthouse it was extremely difficult to distinguish the lights of other vessels. The rule of the road at sea is to keep to the right. When approaching another vessel it is the custom to turn to starboard (right) and show your port (left) light, which is red. The Narrows, at the entry to Vancouver harbor, is being dredged, so that there is little room to spare. The bewildering effect of the many lights, fixed or moving, and the difficulty of distinguishing those that were meant to guide the navigator, gave me some idea of the alertness required in the pilot house. Undoubtedly the short voyage from Vancouver to Britannia is one of the most pleasant the technical traveler can make; the courtesy of Mr. J. W. D. Moodie and his staff made it memorable among my many journeys of observation.

Returning to Victoria, on the way home, we allowed ourselves a couple of days of rest. Meanwhile I went to the office of the Provincial Mineralogist for further information concerning some of the districts visited. Then, by courtesy of Mr. and Mrs. Robertson, we were shown some of the environs, including the cement works and gardens of Mr. R. P. Butchart, on Tod inlet. The manufacture of cement was highly profitable a few years ago, notably during 1910 and 1911, when railroad construction was active on the mainland and the building boom was at its height. In this locality, 12 miles north of Victoria, the limestone lies under clay and adjacent to tidal water. The plant has a capacity of 3000 barrels per day, the 'semi-wet' process being employed. After the limestone has been crushed it is mixed with clay in the proper proportions and 31% of water to the consistence of a rich cream. This mixture is then roasted in a 'kiln' with finely ground coal made from the screening known as 'washed pea' and 'washed slack,' the consumption of coal being in the proportion of 50 tons per 1000 barrels (a barrel weighing 350 pounds). The kiln is a rotating iron cylinder 170 ft. long, tapering in diameter from 10 to 9 ft. Three other kilns are smaller, from 125 to 150 ft. long, and with a minimum diameter of 7½ ft. From this the 'clinker' emerges in particles up to 1 inch in size, to which 3½% gypsum is added as a 'retarder,' that is, to prevent the cement from setting too quickly. Thence after passing through a cooler the new mixture goes to Sturtevant ring-rolls, by which it is pulverized, in two stages, to 20-mesh and then re-ground in 10 tube-mills (in several sizes, 6 by 22, 5 by 22, and 6 by 18 ft.) to a dust 88% of which will pass a 200-mesh sieve. In the tube-mills 4, 5, and 6-inch chrome-steel balls are used for preliminary reduction, then flint pebbles, then steel slugs. The sacking of the cement is done by tying the neck of the bag, but leaving a hole at one of the bottom corners with a flap inside so that it closes automatically when the bag is filled. This is called the Bates valve-bag.

So much for arid technology. This manufacture of cement furnishes a financial and physical background for a lovely pleasure. Walking with an eye on the chimneys of the cement works, the visitor passes through a cleft in the rock and suddenly finds himself looking down upon a sunken garden, the conversion of an abandoned quarry, the bottom of which has been leveled into velvet lawns while the loose stones have been piled into rockeries over which flowering plants are climbing in glad profusion. Wild duck—their wings clipped—swim on a little lake. Water runs amid the parterres and a waterfall adds sound to color. The masses of bloom gladden the rocky ramparts of the quarry and deepen the mystery of the untutored wilderness in the background.

Let that be the closing chord. In large measure it typifies British Columbia: the homes, the fields, and the gardens nestling amid the rugged mountains, the primal forests, and the wide waterways of a land rich in natural resources and richer still in a people that has responded to the call of an old tie and the impulse of a great devotion.

Potash-Bearing Minerals of California

By Herbert Lang

INTRODUCTION. The extreme scarcity and enormous rise in price of potash compounds incident upon the War and the shutting off of German importations have made the development of a domestic supply imperative. Every State in the Union possesses potential potash, either in the form of organic or inorganic reserves, but in no case can an adequate supply be obtained immediately, and a prolonged struggle will be required to overcome the evils of a situation brought about by the preceding years of free-trade in chemicals.

It goes almost without saying that California, so rich in varied mineral resources, possesses ample supplies of potash and in varied forms. Among vegetal substances her seaweeds are pre-eminent in their potash contents. In the Searles lake-bed she possesses perhaps the most extensive deposit of the kind on this continent. In her widely scattered feldspar formations she appears to have an inexhaustible reserve, which, when suitable methods of extraction are developed may displace all other sources of supply.

It was natural that when the dearth of potash was realized fully that men should turn with feverish energy to the task of utilizing the material most immediately available, and to which the simplest methods of extraction are applicable. Such are the dry lake-bed salts, and the ash of the kelp, from both of which the potash salts may be dissolved by water. The easy solubility of the chloride, the sulphate, and the carbonate of potash favors extraction and purification, but it so happens that corresponding salts of sodium, of equal or greater solubility, accompany the potash contained both in the lake-beds and in the seaweed, so that some embarrassment is felt and some inconvenience occasioned by their presence. The desert salts of the dry lakes contain, especially at Searles lake, at least four sodium compounds that inter-crystallize with the potash, which exists mainly as chloride, and prevent its easy separation. These are sodium chloride (common salt), the sulphate, the carbonate, and the borate—all valuable chemicals in their place, but not so valuable when in the wrong place. If it becomes necessary to transport, crystallize out, and throw away a ton of common salt and half a ton of sulphate of soda in order to obtain a hundred-weight of salable chloride of potassium, the operation may not prove lucrative.

A large number of native rocks contain potash, but those rich enough for making potash are not above three or four in number. At the head of these stands orthoclase—potash feldspar—a usual constituent of granite and gneiss, which are well distributed in many parts of the State. Granite and gneiss of themselves would not serve to make potash, but pegmatite, a related rock, in which the three constituents, mica, feldspar, and quartz

are segregated into comparatively coarse particles, is the usual source of feldspar, which is separated from the other two by cobbing. The mica, should it prove to be muscovite, the light-colored species, also contains potash and except for its slightly greater content of iron, is equally promising as a source of potash. Both are natural silicate minerals, composed chiefly of silica, alumina, and potash, along with various subordinate impurities, chiefly soda, lime, magnesia, and iron. Although the theoretical composition of orthoclase shows a content of 16% and above of potash, I have not found by actual analysis a greater proportion than 14.2% in the course of fifty or more determinations, on California feldspar. I think that the average cannot be far from the percentage stated above, namely 10%. The alumina runs invariably from 18 to 19%, the silica keeping close to 65%.

The average potash content of muscovite is about 10%, thus sensibly equaling orthoclase in this regard. It is less abundant, but perhaps more widely distributed. Viewed as a source of potash, mica would possess an advantage over orthoclase as containing less silica, but it contains more magnesia, which would prove objectionable as interfering with crystallization.

POTASH FELDSPAR is known to exist in many localities in California, several of which are easily accessible, lying upon or near important transportation lines. One of the best known of these deposits is near Chualar, in Monterey county, from which several shipments to the potteries have been made. The crude (unground) rock from this source commands about \$7 per short ton laid down in San Francisco. It is said a considerable exposure of good rock occurs there. Extensive deposits are reported from Kern county, but at some distance from the railroad. The best-appearing feldspar as yet offered on the market is that of the King quarry, in Inyo county, where large quantities are said to exist. This rock is remarkably white, clean and well crystallized, and should prove well adapted to the making of potash. It can be had at about the same price as above-mentioned. Probably twenty or more localities have been reported at one time or another, here and there throughout the State; so there seems to be no dearth of feldspar, at least.

Assuming a price of \$7 per ton at the factory, and an average content of 10%, or 200 lb. per ton, it appears that the raw material for one pound of K_2O would cost $3\frac{1}{2}$ cents. While K_2O is not a salable product, of course, KHO , the hydrate, called usually caustic potash, is sold in large quantities, commanding a price at ordinary times of 6 to 7c. per lb., but selling now for about 80c. Most potash salts are selling now for from ten to thirteen times their normal price. The native chloride from Stassfurt, that brought \$32 per ton before the War,

commands now \$425 per ton, and the sulphate is almost as dear. These, he it remarked, are impure commercial salts, containing from 10 to 20% impurities. Refined potash compounds are not quoted now in cents per pound—the quotations are in dollars. Nine-tenths of the potash came from Germany, and under the stimulus of free trade we paid the Teutons far more than a hundred million dollars for it in ten years, getting it so cheaply that all domestic supplies were cut off. But the loss and inconvenience arising from the interruption of imports during the past two years has more than offset the gain previously made, and we have neither potash nor a potash industry. I venture to say that if we had had a protective tariff stiff enough to have kept the German product out we could have saved the \$100,000,000 and built up an industry that would have protected us from the consequences of foreign wars. It is a great object-lesson in political economy.

ALUNITE. Next comes the mineral alunite, which is found in the arid parts of the West, and is undergoing exploitation for the same purpose. Alunite is a sulphate of potash and alumina, the former becoming soluble in water after heating. Here we find a decided difference, because neither mica nor feldspar are affected in the least by water, nor will they yield to even the strong acids. Since special measures are not necessary for rendering the valuable base soluble in case of alunite, this mineral becomes more immediately available for potash production than the silicates, and is leading them in exploitation. However, it seems to occur only in comparatively inaccessible situations, whence transportation becomes a ruling factor. We have to consider also the important fact that no useful by-products can be expected from alunite, whereas feldspar is capable of yielding two at least of these—precipitated silica and alumina sulphate, which may go far toward reimbursing the total cost of reduction. Such considerations must be had if we would found the manufacture on an enduring basis.

The deposits of alunite thus far reported do not seem to contain potash to so high an extent as ordinary orthoclase; in fact, they do not appear to average over 6 or 7%. But as the mode of extraction does not contemplate the decomposition of the whole mass, the remaining matters may be disregarded.

LEUCITE rock, another source of potash, is a complex lava, in which the potash exists in no less than three distinct silicate minerals, namely, leucite, feldspar, and phlogopite or magnesia mica. The leucite and the mica are soluble in sulphuric acid, but the feldspar is not; and acid treatment only avails to extract perhaps two-thirds of the total potash. Added to this, the accessory matters, of which the rock contains a great many, complicate the processes of separation. Chemists have found some 20 constituents, of which over a dozen are basic, there being iron in two forms, magnesia, and other troublesome matters, which makes the problem of separation one of great complexity. The average potash contents, as shown by the few analyses at hand, does not

exceed 10 or 11%, which puts leucite rock into the class with potash feldspar and potash mica. Perhaps the most serious objection to this rock, called occasionally *wyomingite*, is that it is found only in Wyoming, whence the transport of its products would be subjected to heavy charges.

ANALYSIS OF POTASH MINERALS. In this journal of August 5, 1916, W. B. Hicks describes some useful field-tests for potash in the common minerals, to be performed with a minimum of apparatus. Should the investigator be possessed of more facilities and skill, he may continue his researches farther. The estimation of the alkalis in complex minerals has always been held to be beyond the resources of ordinary chemical manipulators, but it has become a necessity to make the determinations rapidly and accurately. I shall describe my method, in which there is nothing especially new. As a rule it is not requisite to determine anything except the alkalis, nor would we desire to estimate the soda were it possible to escape doing so; but the determination of one alkali involves that of the other. As there is no proper precipitant for potash or soda, we are compelled to remove all the other bases from the solution before it becomes feasible to isolate and weigh the alkalis. I weigh out a gram of the finely powdered mineral, having first dried it at the boiling-point of water to eliminate moisture. I wish to emphasize the matter of pulverizing, since the success of such operations depends upon getting the substance into the finest possible condition at first. I mix the substance with about 5 cc. strong hydrofluoric acid (about 35%) in a lead dish of good size, and place on the water-bath. After the violence of the reaction has ceased, I add successive small amounts of hydrochloric acid and evaporate to dryness, when the residue, consisting of chlorides of the various bases, along with a small amount of gelatinous silica resulting from the decomposition of the silicon fluoride by the water brought in by the acid, will be found as a loose powder, provided that sufficient acid was used. The dried powder I then transfer to a porcelain crucible and heat to low redness, for the purpose of expelling as much as possible of the aluminum chloride which would otherwise afford a bulky and annoying precipitate at a later stage. The addition of a few drops of nitric acid during the evaporation has served to oxidize all the iron present to the ferric form, ferric chloride being somewhat volatile also. After taking up with water and boiling, the various remaining chlorides are dissolved, when, without stopping to filter the silica, etc., I immediately precipitate the iron, lime, alumina, and all other bases with a mixture of ammonium hydroxide and carbonate, added in excess, boil and filter, thus getting rid of everything except a part of the magnesia, which is somewhat soluble in ammoniacal compounds.

Evaporating the filtrate to dryness, igniting the residue to drive off all the ammoniacal compounds, and again dissolving and filtering, gives a solution containing the chlorides of the alkalis in a state of purity. It is often necessary to repeat the evaporation with the

addition of a little ammonium carbonate to get rid of final traces of magnesia. The chlorides are dried, ignited, and weighed together. From this point the processes diverge somewhat. We may precipitate potash next as chloro-platinate in the usual manner, but this involves the use of a weighed filter, since the salt decomposes on ignition and at a temperature as low as 150° C. Or, we may estimate the chlorine in the residue by precipitation with silver nitrate, calculating back to the combined weight; but this method, while rapid and easy, is indirect, and few operators feel like relying upon it. Reduction of the chloro-platinate by means of oxalic acid is recommended by some; but I have done the best by cupelling the burnt filter with the chloro-platinate with silver-free lead, and weighing the residue of metallic platinum. If the operator has an assay-furnace at command, I should say that this is the best and most accurate proceeding, and certainly not difficult. Experienced chemists will understand why the customary method of decomposing the silicates by fusion with alkaline carbonates are inapplicable here, and why hydrochloric is chosen instead of sulphuric in the preliminary decomposition. The object is, of course, to find a short method for determining the potash alone, although the discovery of the amount of sodium present is useful.

Treatment of Molybdenite

At Renfrew, Ontario, the International Molybdenum Co. recently started a new treatment plant of 50-ton capacity in 12 hours. From ore containing as low as under 1% molybdenum a 70 to 80% concentrate is obtained. Grinding is not done below 60-mesh. A gyratory-crusher and rolls are used for this. The crushed ore is fed dry to a drum revolving in water at the head of the flotation machine. A large quantity of the sulphides, including most of the molybdenite, is floated. The stream passes down a gently-inclined box 12 ft. long. The iron sulphides are carried along with the molybdenite until they strike baffle-boards, which help to sink them. The baffles are vertically placed boards, over the edge of which the water carries the molybdenite. They interfere little with this mineral, but cause sinking of the other minerals. At Orillia a refinery makes molybdic acid, ammonium molybdate, and ferro-molybdenum.

Near San Diego, California, a 50-ton flotation plant was recently started by Shinn & Shinn of Sacramento to treat a low-grade deposit of molybdenite. At present prices, \$1.50 to \$1.75 per lb. of 90% product, a good profit is made on 1% or under, ore.

BAUXITE, the oxide of alumina, occurs in considerable quantities in British Guiana, in South America, and Americans have secured leases on some of the deposits.

A NATURAL-DRAFT COOLING-TOWER, with a capacity of 7300 gal. per minute cooled from 115 to 85°, was recently erected at a steel plant at Anderson, Indiana.

Mark Twain as a Metallurgist

By G. H. Clevenger

Mark Twain had a brief but highly illuminating experience in metallurgy, to which he devotes some space in 'Roughing It.' After having ascertained how long and dismal a job it was to burrow into the bowels of the earth and get the coveted ore, he learned that this was but half the work, and that to get the silver and gold out of the ore was the other half of a dreary and laborious task. In the course of a vivid description of a pan-amalgamation mill of the period, he observes: "One would not suppose that atoms of gold and silver would float on top of six inches of water, but they did."

Mark stayed in the mill only one week, when he told his employer that, while thoroughly infatuated with the business, he felt constrained to ask for an increase in salary. Whereupon the superintendent replied that he was paying him \$10 per week, and that he thought it a good round sum: "How much did he want?" Mark replied that he wished \$400,000 per month and board, which was about all he could reasonably ask, considering the hard times. Needless to say, he was ordered off the premises, but later, when reflecting upon those days and the exceeding hardness of the labor, his only regret was that he had not asked for \$700,000.

All that would have been necessary to put flotation in operation in the early Comstock mills would have been to go to the adjoining hills, gather the sage-brush abundantly growing there, subject it to destructive distillation, and add the tar-oil thus produced to the rapidly revolving pans, which would have made splendid agitators. The chemicals generally used—mercury, bluestone (copper sulphate), and salt could, of course, have been omitted. True enough, as recorded by Dan De Quille, friend of Mark Twain and co-editor with him on the Virginia City *Enterprise*, in his humorous volume entitled 'The Big Bonanza,' pseudo-investigators had gone to the 'hills' and gathered the sage-brush, and from it steeped a tea, which had been added to the pans, but this had not proved efficacious, for not only the essential oil contained in the sage was present, but also the extract of the tannin, which is now known to be deadly to flotation.

Had Mark Twain but realized that the floating atoms of gold and silver that he and others so persistently tried to make sink were but the manifestation of a phenomenon that was later to revolutionize metallurgy, he might have remained a mill-man for the paltry \$10 per week. But if the world might have had another famous metallurgist, we would not have had Mark Twain; and after all, who would trade a Mark Twain for a prosaic metallurgist?

AIR-PRESSURE tanks carrying over 25 lb. per sq. in. are to be inspected biennially by the California Industrial Accident Commission. There was one fatal accident in 1915, 6 permanent and 343 temporary injuries.

Measuring With the Steel Tape in Mine-Surveying

By Walter Scott Weeks

In a previous article* I developed a graphic method for correcting in one operation a measurement by a steel tape, for sag stretch, temperature, and initial error in the tape. It is the purpose of this paper to present a few suggestions for increasing the accuracy of the field-work.

In mine-surveying the vertical angles are measured from the head of the instrument to some definite point

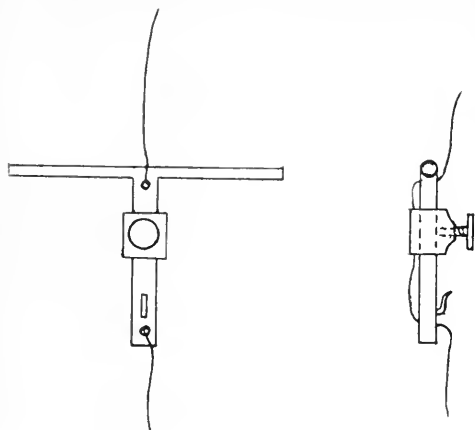


FIG. 1.

on the plumb-bob string—a bit of wax, a match, or a target. The target I use is a small brass cross that can be moved up and down the string and clamped in any position. The construction is shown in Fig. 1. At the lower end of the cross may be seen a hook. This hook, with a small ring on the string near the bob, forms a means for rapidly shortening the plumb-bob string when the station is in the back.

On the end of the plumb-bob string is a hook for attaching it to a spad.

If the station is in the floor the cross is moved down so that the distance from the end of the bob to the cross is the desired height of point.

If the station is in the back, the cross is moved up until the distance from the centre of the spad to the cross is the desired height. The ring on the plumb-bob string is then slipped over the hook on the cross and the plumb-bob string is thus shortened in a moment. The portion of the string above the cross has no loose ends to confuse in the sighting for horizontal angles. Fig. 2

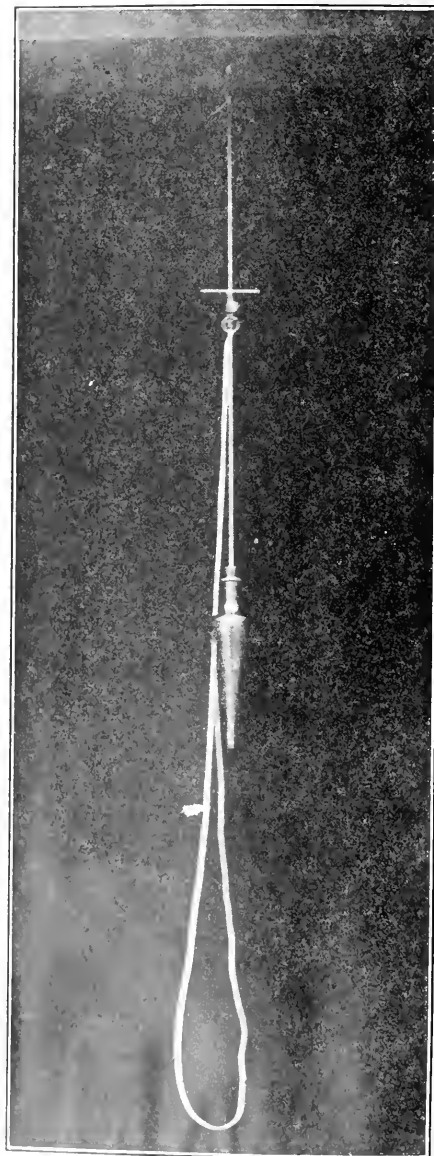


FIG. 2.

*M. & S. P., October 28, 1916.

shows the plumb-bob hanging from a back-station.

Owing to the fact that it is necessary for the head chain-man to hold the tape at any point along its length, some sort of a grip is desirable. For holding the tape I

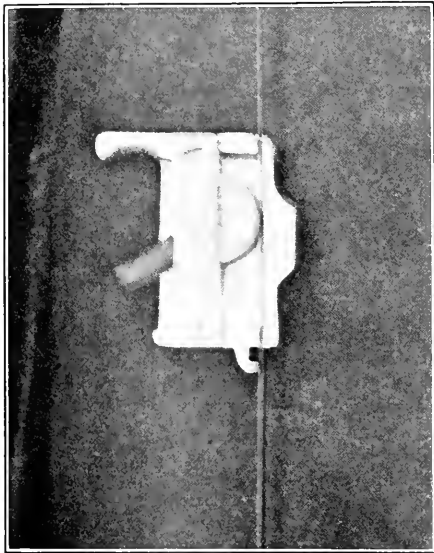


FIG. 3.

devised the grip shown in Fig. 3. It operates on the principle of the eccentric. It is cast in aluminum, and will grip a tape of any thickness or width.

If the station is in the back it is necessary only to

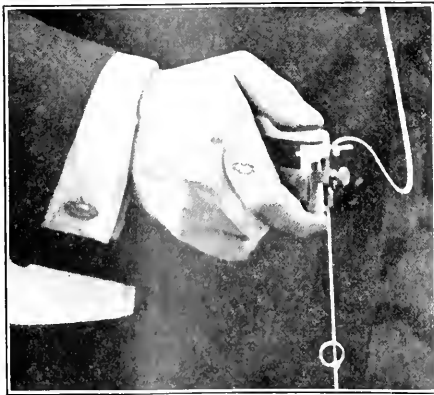


FIG. 4.

grip the tape and hold the proper foot-mark at the cross.

If the station is in the floor, the aid of this particular grip becomes more apparent.

With a station in the floor, the surveyor must keep the point of the bob touching the tack, and he must hold the

proper foot-mark of the tape at the cross. This is easily accomplished by the use of the grip. The cross is slipped into the bracket provided for it on the front end of the grip. See Fig. 4. The tape is placed in the grip with the proper foot-mark directly over the cross. The chain-man can now give his whole attention to keeping the point of the bob over and touching the station-point. See Fig. 5.

The tenths and hundredths are read at the instrument. Tapes can be obtained with an extra foot on the zero end graduated backward from the zero point. With

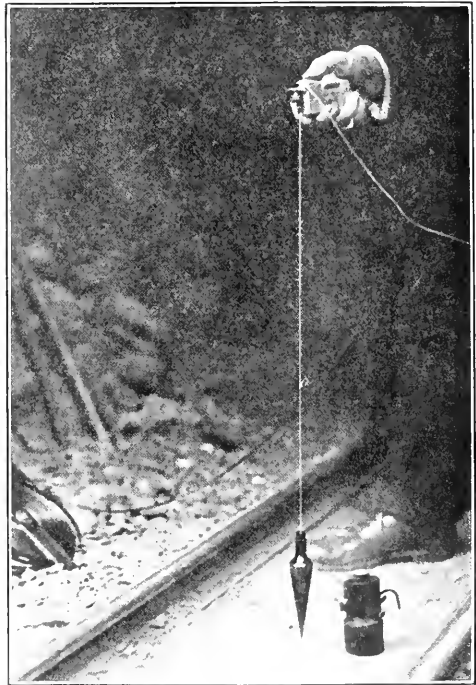


FIG. 5.

such a tape the tenths and hundredths are read directly and, added to the reading at the cross, give the measured distance. There should not be over two inches of blank tape at the end, because a longer strip throws the handle too far back for the operator to hold and read at the same time. Fig. 6 shows a tape of this description.

In order that the tape-correction chart¹ may be used it is necessary that the 'working-pull,' which is 2000 times the weight of one foot of tape, shall be exerted.

The spring-balance best adapted to this work is balance No. 633 of the Chatillon Co. It has a range of from 0 to 30 lb. This can be obtained from any instrument company. I have replaced the ring on the end by a bar and placed an adjustable stop so that the working-pull

¹'A Graphic Method for Correcting Steel Tapes.' M. & S. P., October 28, 1916.

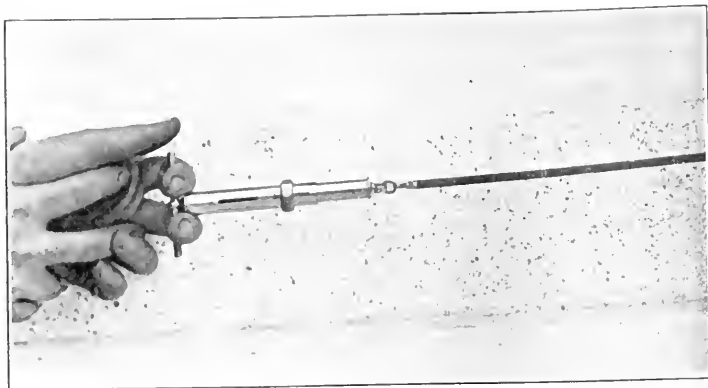


FIG. 6.

may be exerted without looking at the balance. Fig. 6 illustrates the device. The stop is merely a collar that slips over the balance. It is held in place by a set-screw. See Fig. 7. The pin opposite the set-screw fits into the slot in the balance. This pin holds the slot open when the set-screw is tightened.

A weight equal to the working-pull should be hung on the balance and the stop put in place without regard to the numbering on the balance.

Of course, the character of the survey must determine the degree of accuracy to be sought, but in any event the engineer ought to know what degree of accuracy he is approaching. The spring-balance arranged as in Fig. 6 is just as convenient as an ordinary handle. If the

working-pull is exerted the engineer may be sure that the combined errors due to sag and stretch will not be greater than 1 part in 4000. This statement is true for a steel tape measuring 200 ft. or less and holds for all angles of inclination. If greater accuracy than this is desired the temperature must be noted and the corrections taken from the chart.

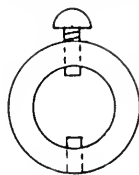


FIG. 7.

W. W. Johnstone, of the Bausch & Lomb Optical Co., 154 Sutter St., San Francisco, has consented to make a few grips and crosses, so that if my suggestions should appeal to anybody he may obtain these devices.

My thanks are due S. J. Ogilvie and E. W. D'Evelyn, students in the University of California, for the photographs.

THE METRIC SYSTEM of weights and measures was in September made law at Lima, Peru. There has been a "lame metric system" in the republic for some years, but now the law must be followed.

THE TOTAL VALUE of the mineral production of British Columbia up to the end of 1915 was \$516,270,253.

OIL PRODUCTION of Japan during 1915 totaled 3,015,327 bbl., an increase of 272,807 bbl. over that in 1914.

Dredging in Australia

During 1915 there were operated in Victoria, Australia, 42 dredges, 17 pump-hydraulic plants, and 9 jet elevators. The dredges dug a total of 9,727,975 cu. yd. of gravel, yielding an average of 6.4 cents per yard. The average depth worked was 18.7 ft., the deepest being 39 ft. There were 566 men employed. Dividends totaled \$120,000 from 15 companies. The buckets varied in capacity from 3 to 8 cu. ft.,

and discharged from 10 to 20 times per minute. These companies are only capitalized at from \$7500 to \$140,000, excluding the Briseis, which is a subsidiary of a large concern operating in Tasmania. Its four boats treated over 1,250,000 yards, for 5600 oz. The initial cost of Victorian dredges is low, being only \$60,000 for the largest, others being \$17,000 to \$35,000.

The jet elevators moved 152,172 cu. yd., yielding 14.4 cents per yard. They employed 43 men. The initial cost of plant is under \$5000, most of them being \$500 to \$2000. As the operations are private no profits were reported.

The pump-hydraulic sluice system moved 1,849,967 cu. yd., yielding 14.8 cents per yard. Cocks' Pioneer, the largest, declared a dividend of \$24,000.

Over 80 tons of black tin was recovered from these operations. From 1900 to 1915, inclusive, placer mining in the State has yielded 8.4 cents per yard from 231,640,195 cu. yd. treated. In 1915 the total gold won was just under 50,000 oz., and dividends amounted to \$145,000.

The Sludge Abatement Board regulates mining in Victoria with the object of preventing impure water, sludge, or mining debris from causing injury to water-courses or farming land. The volume of suspended solids, etc., carried by streams, also chemical analyses of mine waters are given in the Board's annual reports; also notes on restraining mill and dredge tailing.

INDICATIONS of petroleum were noted in South America as far back as 1788, when Humboldt described the oil seepages and mud volcanoes of northern Colombia, but little was done toward oil development until 1896 when active operations began in Peru. Even at the present time commercial production is confined to Peru and Argentina and the combined yield of the two countries in 1914 was only 2,500,000 bbl., or 0.6% of the world's production. Practically all the countries of South America afford oil indications of more or less importance, but principal attention is now being given to Colombia, Venezuela, Peru, and Argentina.

Mining in the Jerome District, Arizona

By Charles F. Willis

The Jerome district has been foremost in the progress of Arizona during the past month. Old mines have revealed new orebodies; new mines have found orebodies; and new organizations have been formed with great success. The Verde or Jerome district for many years has been a wonderful producer of wealth. The rich deposits of copper ore have made local shares exceptionally popular with the investing and speculating public. The United Verde Copper Co., with dividends aggregating upwards of \$38,000,000, is well known in the mining world. Fortunes were spent by other companies in the Verde district in an effort to open other fine orebodies, and it was through the persistent work of the United Verde Extension Co. that the secret of Jerome's rich bodies of copper ore was solved.

A few years ago Extension shares were quoted in cents, now they are selling at dollars each, over \$40. Its rise has been a great surprise, especially on the Stock Exchanges. The Jerome copper belt is benefiting therefrom, and issues of shares by new companies are eagerly snapped up.

It has been announced that steam-shovel operations are to be commenced at the United Verde within the next six months, as a means of increasing its ore supply. The low-grade surface ore around the old smelter at Jerome is to be so excavated and transported to the Clarkdale smelter for treatment. There are hundreds of thousands of tons of this ore, particularly in the hill just north-west of the site of the old plant. It is proposed to steam-shovel right down to the fire that has been burning for 14 years in the Hampton stope. The fire can then be extinguished from above, thus ending a famous mine fire. Only preliminary work is now being done preparatory to starting a large shovel digging surface ores. At the request of the United Verde management, Louis S. Cates, manager of the Ray Consolidated, paid a visit to Jerome last week and looked over the ground that is to be moved by this method. Mr. Cates is an authority on steam-shovel operations, having had much experience in Utah and other States. The resignation of Will L. Clark, manager of the United Verde Copper Co. since 1904, is generally regretted here. His work has been excellent, and he uplifted the tone of the district.

The United Verde Extension has declared No. 2 dividend, of 50c. per share. A large surplus is being accumulated for future needs. The monthly output from 8000 tons of ore is around 3,000,000 lb. of copper.

The Green Monster has been another attractive company. Shares were over-subscribed six times before put on the market. From this mine it is reported that an orebody has been cut averaging 17% copper. The company has taken over the Copper Chief group, which adds greatly to its value, as the latter is already a producer having shipped ore for several months.

The Dundee Arizona is attracting considerable attention, its shares having almost doubled in market value within the past two weeks. Co-operative mining has been started in the district, and recently a deal was consummated with the Extension for a joint adit that will develop both properties. The large shoot in the Extension has been found to be on the same fault, about 1000 ft. north-west of the Dundee. The new machinery for Dundee is at the mine, and includes a 60-hp. hoist, a 12 by 10-in. compressor, and a 3600-gal. Cameron sinking-pump.

The Verde Apex and the Venture Hill have completed a joint development scheme on an equal expense basis, with a view to opening each at depth and exploiting the orebody recently encountered in the Venture Hill adit. The Venture Hill has proved the presence of high-grade ore, having found native copper in the schist. The drift in which the metal was found is now in 520 feet.

Another company that is exciting much favorable comment is the Calumet & Jerome. This company has recently installed a 285-hp. Diesel engine, generator, exciter, 112-hp. hoist, and a compressor with a capacity of 513 cu. ft. per minute.

Verde Hercules has let a contract for diamond-drilling to N. Bertrand of Bisbee. This is not the first attempt at diamond-drilling as a method of prospecting in the Jerome district. It is said here that a Los Angeles company had a drill operating on the Harryhausen property some eight years ago, and cut a rich orebody at a depth of 1000 ft. The story is that at that time the company became involved in legal difficulties, due to speculation in Oklahoma oilfields, so the drill-hole that opened the ore was covered up. This story is believed by the old-timers of Jerome. The Verde Hercules is very favorably situated, being only a mile from Jerome and on the U. V. & P. railroad.

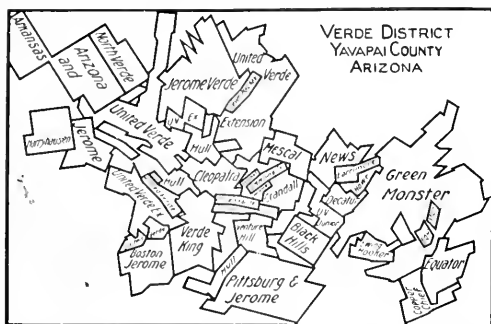
The settlement of the legal entanglements of the Hull Copper Co. has been one of the most important developments in the district, for the company has a mine of value. The new directors were selected at the annual meeting of the shareholders recently held, and include Will L. Clark, formerly manager of the United Verde, R. D. Tally, present manager, and Thos. Taylor, smelter superintendent for the same company. The Clark interests purchased a controlling share in the company a short time ago.

Jerome Superior is another one that borders on the United Verde, Verde Extension, Arkansas & Arizona, Jerome Daisy, Jerome Victor, and Verde Hercules. This property was recently sold to George Mitchell of Los Angeles for \$185,000.

Dave Morgan, superintendent of the United Verde Extension, has been appointed by the Verde Combination as its general manager. It is reported that George Kingdon, general manager of the Greene Cananea, will take charge of the Extension. The Verde Combination is well financed for an extensive campaign of development, having \$400,000 and 500,000 shares in the treasury.

The Arkansas & Arizona is a hive of activity. Recently L. D. Ricketts, John C. Greenway, general manager of the Calumet & Arizona, Ira Joralemon, and Philip D. Wilson, geologists for the Calumet & Arizona, and Will C. McKee, chief mechanical engineer for the same company, visited the A & A property. Although the object of their visit is unknown, there has been more activity at the A & A since that time, the force having been materially increased. This is one of the older mines of the district, having been worked extensively some years ago.

The Jerome Daisy Copper Co., which has been in existence only two weeks, was a sensational promotion. In nine days from the time of offering the reorganization stock, the secretary, A. J. Kisselburg, was returning



checks, drafts, and money orders, owing to over-subscription. Practically all of the shares were sold within Arizona.

The United Verde Consolidated has been another successful and rapid promotion. This company proposes to explore by diamond-drilling, and is about to let a contract for 20,000 ft. of work, with two drills.

A new promotion a day has been almost the rule for the Verde district, and local business men have organized to stop wild-eating before it starts. The idea is to use some sort of censorship over new mining schemes, and news of the district, to prevent, if possible, the public from being fleeced by promoters who are attracted merely by the prosperity of the district, and the ease with which Verde stocks are selling. While nothing will be done to discourage legitimate mining, everything possible will be done by this civic league to prevent wild-eats. A committee was appointed to formulate a working plan, consisting of Will L. Clark, Dave Morgan, and W. S. Humbert, managing director of the Green Monster, acting for the mining interests, and R. J. Stevenson, J. C. Scott, and Charles Du Bois acting for the business men.

Judging by the full-page advertisements in Arizona papers, urging people to buy shares in Jerome and other districts' new mines, promoters are exceptionally busy.

Jerome is full of activity, practically all of the companies operating having sufficient money in their treasuries to insure complete development. For many years this was thought to be a one-mine centre, but it is no longer considered in that light.

Mining in Cuba*

The prevailing high price of the base metals has given a great impetus to the mining industry of Cuba. In consequence, a large number of concessions has been granted by the Government; many of the old mines have been re-opened and much development work has been done; prospectors have uncovered numerous veins, some of which give promise of becoming productive mines.

Particular attention has been directed to the province of Pinar del Rio, in the extreme western part of the island. In 1915, no less than 95 concessions, to mine in this province, were granted by the Government. Of these, three were for the exploitation of iron deposits and the remainder for copper. Most of the mines are in the development stage, except the Matahambre mines and those of Asiento Viejo.

The Matahambre mines were opened in April 1913 and have been under continuous development since that date, producing a total of 90,000 tons of ore. At present 500 men are employed in mining 3000 tons of ore per month. The ore, chalcopyrite, is sorted at the mine into two grades; that containing more than 10% copper is shipped to the United States, while that assaying less than 10% is stored for future treatment. Average shipping ore contains 15% copper and one ounce of silver per ton. The ore is hauled by wagon 11 miles to the coast, where it is loaded on steamers. Negotiations are pending for the building of an aerial tramway, 7 miles long, to replace the haulage of ore with teams.

The Asiento Viejo mines have shipped some high-grade ore but are handicapped by the difficulty of transporting the ore to the coast. Many small mines are being developed but none has reached the stage of production. The eastern province is the oldest and most important mining district of the island. Here are mines of iron, ferro-manganese, and copper. At Santiago de Cuba is the mine of the Cuba Copper Co., formerly the El Cobre. This was the first copper mine worked by white men in the Western hemisphere, its history dating back to 1532, when it was opened by the Spaniards. Operations were intermittent until after the Spanish-American war, when it was acquired by American capital.

The Jaraguá Iron Co. and the Spanish-American Iron Co. are large producers of iron ore. Some ferro-manganese ore has been mined owing to its rapid increase in value in the United States. Practically no gold nor silver is mined on the island. Prospecting for oil has been done in La Habana province with encouraging results. A small amount of crude asphalt has been mined and exported. This industry gives promise of developing to considerable importance. The mining laws have been revised and made more favorable to the operator. With the increase of transportation facilities and the development work now in progress, Cuba should increase greatly in importance as a producer of metals within the next few years.

*Excerpt from 'Boletín de Minas' published by Secretaría de Agricultura, Comercio y Trabajo de Republica de Cuba.

Mining in Colorado

By George J. Bancroft

The advancement in mining in Colorado this fall has been steady and along well-worn grooves. Leadville is hoisting 2500 tons daily. Cripple Creek is producing over a million dollars per month. The northern counties are keeping up production and bringing in new or long idle districts. The San Juan is doing the same. The zinc centres, like Rico and Redcliff, are establishing a new high-water mark of production. The big drainage projects, such as the four Leadville pumping schemes and the Roosevelt tunnel at Cripple Creek, are reaping the reward of diligent industry, and ore from freshly-drained ground is now a material factor in the daily production.

There have been few new strikes on the surface this season, but there have been several ore discoveries in old-time producers this fall that are important. Among these the two most noteworthy are the strike at the Columbus in the La Plata mountains and the strike in the Capital Prize at Georgetown.

The La Plata mountains are in the south-west corner of the State. Georgetown is 50 miles west of Denver. Years ago [in 1896] the Columbus was developed under the direction of T. A. Rickard. Financial depression and the death of one of the owners caused a cessation of activities from 1898 till the spring of 1916, when work was resumed on a cross-cut tunnel. Late in August the vein was cut and was found to be 45 ft. wide, the entire width being ore of milling grade. The water in the old workings immediately began to drain into the adit; a raise was started, but progress was slow on account of the down-pour of water. High-grade ore was not anticipated in this enterprise, but some extremely high-grade streaks have been encountered in the raise. This discovery is important because it marks a new producer of substantial proportions.

The Capital-Prize strike is extremely important, for the reason that it has inspired the theory that all of the silver-bearing veins of that locality will become gold-bearing in depth. The strike was made 1700 ft. below the surface. The orebody is both large and rich. I hesitate to quote figures given me by those who have seen the vein or figures that have been published in the local press because they seem too good to be true, but it is sufficient for this review to state that this shoot of gold ore is far better than any discovery in higher levels in the same locality. Hence the theory that the top of the gold zone is, say, 1500 ft. below the surface. Whether this theory is true or not it has caused renewed activity in the vicinity of the Capital-Prize.

One of the praiseworthy lines of advancement that has made notable progress lately is that having to do with 'First Aid' organizations. To Joseph A. Holmes, the first director of the Bureau of Mines, belongs the credit of having started interest in first-aid work. He showed the miners and managers that, in cases of accident, immediate attention is necessary and that it is not safe nor

humane to rely on the delayed attendance of the company physician. The Colorado Fuel & Iron Co. at once adopted his ideas with enthusiasm. First-aid crews were organized and fully equipped, rescue-houses were built at all the mines of the company. A first-aid crew consists of four men and a captain. They are thoroughly trained in all sorts of rescue and first-aid work. A rescue-house consists of a small dispensary and a room so equipped that an operation may be performed, if necessary, before removing the patient to a hospital. Draeger oxygen-helmets are considered very important in rescue-work because the wearer can go into places where there is smoke or gas. The helmets, however, are expensive, and many mines cannot afford them. Following the initiative of the Colorado Fuel & Iron Co., coal



mine after coal mine organized first-aid crews and provided more or less equipment, until now 85% of all the coal mines in the State have first-aid organizations.

Following the lead of the coal mines the metal mines are organizing first-aid crews and providing equipment. The Smuggler at Aspen has a full outfit, including six Draeger helmets and an ex-Government man named Scofield in charge of the work. The Yak Tunnel at Leadville has four crews and a rescue-house. The work is in charge of a trained officer, A. L. Assig. The Smuggler Union at Telluride, the Newhouse Tunnel at Idaho Springs, the Vindicator and the Portland at Cripple Creek are among those that have some sort of a first-aid organization. John Cortellini, the famous lessee at Leadville, keeps a trained nurse named Helen Smith, at Garbut shaft. Miss Smith told me that her principal occupation was dressing cut fingers. "But," she added, "since I have been tying up the cut fingers, there hasn't been a man laid off on account of an infected wound, while before I came there were lots of them."

Colorado is fast becoming a financial centre for oil enterprises. There are now three producing oilfields in Wyoming; the Lost Soldier field is probably a fourth. All of these fields have been financed largely with Colorado capital. To the east of us are the new fields of Kansas, and Colorado men are heavily interested in them. The productive wells are getting closer and closer to the Colorado line. The sulphur deposits of Wyoming are also attracting attention.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

PROBABLE LABOR TROUBLES.—PROGRESS OF DRAINAGE SCHEMES.

The difficulty that has arisen between the local Miners' Union, which is a branch of the Western Federation of Miners, and the operators is rapidly assuming a serious aspect. The Union has demanded a wage increase to \$3.75 and \$4.25 per day and recognition throughout the district. The present uniform wage is \$3.30, but a number of companies operating in the outlying section are paying from \$3.50 to \$4. Mine-owners contend that the time is most inopportune for a wage increase, and they have openly and flatly stated that they will not treat with or in any way recognize the W. F. M. It is reported that the men will strike of their demands are not granted, but the Union leaders deny this by stating that they do not want to strike under any conditions. They are busy organizing the miners, and report that they are having great success, claiming to have secured 700 members within the past three weeks. This active campaign is looked on by operators and businessmen as a forerunner to a strike, should the majority of the miners become members. The situation has taken on such a seriousness that the Commercial Club has assumed an active part in trying to bring about a settlement before the matter reaches a crisis. The State Industrial Commission is also expected to take steps toward adjusting the situation during the week. Notice announcing the demands and intentions of the Union was filed with the Commission last month, and it is reported that the 30 days provided by law to govern the action of employees and employers in the matter of strikes and lock-outs, have nearly expired. After that time, it is feared the Union will call a strike and leave the matter in the hands of the Commission.

Just at this time a strike would mean great depression to the mining industry of the district. Within the year, several large companies have entered the district and have invested large sums re-claiming the flooded areas for development. Of these, two; the Down Town Mines Co., operating through the Penrose, and the Leadville Unit, operating on Fryer hill through the Harvard and Jamie Lee shafts, have practically completed the draining of their territory at heavy cost, and are just entering the prospecting and development stage. The Empire Zinc Co. and the Western Mining Co., who are draining the Pyrene basin through the Greenback and Wolfstone shafts are still pumping. George O. Argall, manager of the Iron Silver Mining Co., who has organized a new concern for unwatering the Mikado and other properties on Iron hill, is just completing re-timbering of the Mikado shaft, and the erection of new surface buildings at the property. Modern machinery for hoisting and pumping has been ordered. None of these enterprises has realized a dollar on the investment, and it is reported that it will be several months before any of them will be on a self-supporting basis. In case a strike is called, and it becomes impossible to secure men without increasing wages and recognizing the union, it is stated that these undertakings will be abandoned, a calamity, the greatness of which cannot be exaggerated.

Aside from these new undertakings, there are a number of companies operating in the district that are shipping such low-grade ore that they claim an increase in their pay-roll would force them to shut-down. Several large iron-manufacturers producers consider that the margin on their ore is less than 50¢ per ton, and in some cases as low as 25¢. These companies

employ several hundred men. A drop in the price of their product would be serious also.

The large companies of the district that are producing high-grade zinc, lead, copper, silver, and gold-bearing ores could afford the demanded increase in wages, and probably would consent to making some advances, but they absolutely refuse to treat with members of the W. F. M. The managers have consulted with the miners in their employ, and have made known their stand in the matter, stating their refusal to recognize the Union or to treat with professional agitators who have been imported to organize the miners, and their willingness to talk things over with their men if on their own responsibility. No promises of higher wages have been made, but it is believed that this stand on the part of the operators will tend to keep the substantial miners of the district—the old-timers—out of the Union.

A large number of the miners in the district consists of a foreign element that is more or less transient. Many of these men have come in from other sections where they belonged to the W. F. M. and have affiliated with the local Union. They are, in a great part, believed to be responsible for the present unrest. The majority of the members of the local Union are foreigners, and are the most enthusiastic over the question of striking. At present, the situation is veiled in uncertainty. No one outside of the Union knows what the intentions of the miners are, and the reports now being circulated throughout the district often prove contradictory. The general opinion is that the final decision will be made by the Union on October 26. In the meantime, many new enterprises that were about to be started have been held, those in charge stating that they will go no further with their plans until the labor question has been settled. Business shows a marked falling-off and money is tight, showing that the people are preparing against the possibility of a strike. Politics have also been dragged into the matter, and it is reported that no steps will be taken until after the elections. Candidates supposedly in sympathy with the Union are up for election to several of the important County offices.

The Down Town Mines Co. has opened a large body of iron-manufacturers ore in the drained area which is being developed through the Penrose shaft. Re-timbering in the shaft is now underway, and it is stated that as soon as this work is completed, a steady extraction of ore will proceed. The pumps installed at the bottom and intermediate stations continue to handle a heavy flow of water, but this is slowly decreasing in volume as the ground drains. The long drift connecting the Penrose with the Coronado is being cleaned-out and re-timbered, preparatory to carrying on extensive developments in that territory. It is reported that the management expects to uncover the important orebodies in that part.

The Wolfstone shaft of the Western Mining Co. has been drained to the bottom at a depth of 1120 ft. Draining of the Greenback shaft adjoining continues, and it is reported that it will be dry within the next two weeks. The Greenback is 1350 ft. deep. The water is now below the 1100-ft. level, and the old steam-pumping plant installed there is being cleaned-up and repaired for service. As soon as it is in operating condition, it will relieve the Layne-Bowler sinking pump now working in the shaft.

The Iron Silver Mining Co., in charge of George O. Argall, is making rapid progress in overhauling the Mikado shaft. The shaft has been fully re-timbered to water-level, just below

the 900-ft. station. A new station, 15 ft. wide, 18 ft. high, and 60 ft. long, is being cut at this point. On the surface improvements to buildings are going on rapidly. The new blacksmith and machine-shop have been erected and equipped. Foundations for a new hoist and compressor are being put in, the machinery being expected during the month. The hoist is the largest that has ever been brought into Colorado.

LORDSBURG, NEW MEXICO

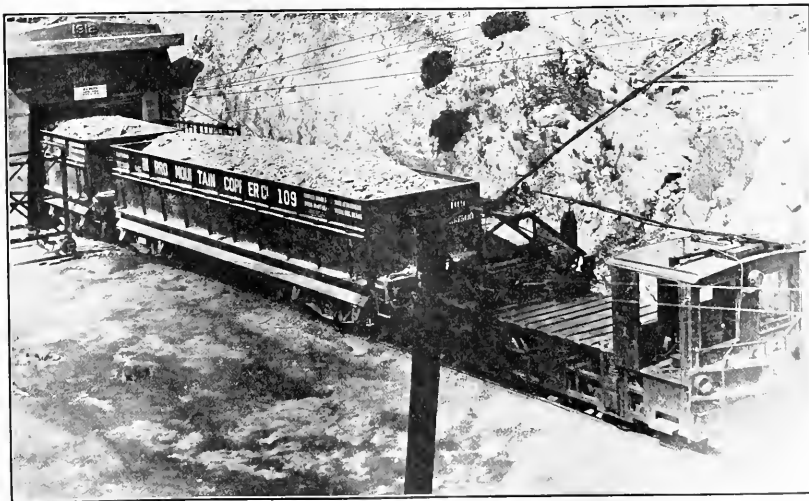
GENERAL CONDITIONS.—CHINO, BURRO MOUNTAIN, BONNEY, OCTO, AND EIGHTY-FIVE COPPER MINES.—OTHER DISTRICTS.

During the recent impetus given new mining enterprises throughout the South-west the State of New Mexico has remained practically immune. There have been no booms of bonanza strikes to cause a rush. Mining in New Mexico is progressing along substantial and encouraging lines. The two

had been encountered. The Bonney is one of the promising mines in this district. The copper ore is the highest grade and of the best shipping quality, running well in gold and silver. About 20 men are on the pay-roll.

At the Lee's Peak mine of the Octo Mining & Milling Co. Wright brothers of Bisbee, Arizona, are engaged in sinking a 500-ft. shaft under contract. At a depth of 90 ft. water was struck, for which pumping machinery is now on the way. A new steam hoist has been received at the mine, and much new equipment is being purchased. California and West Virginia men are financing the Octo company.

The Eighty-Five Mining Co. is producing about 400 tons of ore daily, and has completed sinking to the 5th level, on which extensive development is being done. The company is installing the second unit of its power-plant, having received another 500-hp. Lyons-Atlas, crude-oil burning Diesel-type engine. Experiments are being made at El Paso by J. W.



HAULING ORE AT THE NIAGARA TUNNEL OF THE BURRO MOUNTAIN COPPER CO.

largest metal-mining companies in the State, Chino and Burro Mountain, are making good headway. Few new companies are entering the State, but old ones are returning to activity, while formerly dormant and operating companies are enlarging their outputs or developing capacities.

The Chino Copper Co. has appropriated \$1,250,000 for the enlargement of its mill, and constant changes and improvements are being made at the Hurley plant. The company is keeping its cost down to 7.25c. per lb. for copper, selling it for about 27c.

Construction is paramount at Tyrone, where the Burro Mountain company is mining and milling low-grade copper ore. The company store, which is one of the largest in the State, is nearing completion. The offices and handsome school building are indicative of big things to come at Tyrone. The 1000-ton capacity mill is being operated and ore is being hauled by way of the Niagara tunnel from the mines at Leopold and Tyrone.

In the Lordsburg district Chicago interests have taken hold of the Bonney mine, and preparations are being made for extensive operations in the near future. The indebtedness against the property has been extended, and the mine is substantially financed. During the past month the No. 3 shaft was unwatered, revealing high-grade ore on the 4th level, where operations were suspended some time ago after water

Crowdus, prior to making a decision on the erection of an ore treatment plant at the 85 mine.

Steeplerock is the scene of several new enterprises that are opening mines near the Carlisle. While activity is comparatively light, the centre promises to open on a large scale after the first of the new year.

The Phelps, Dodge & Co. continue development in the Organ district, east of Las Cruces. G. Fraser-Campbell is in charge of the work.

The Pintado Consolidated Copper Co. at Santa Rosa, Guadalupe county, is erecting a 50-ton experimental mill to try methods of treating the copper ore, including leaching.

The McGee company, operating a lead mine at Steins, is buying new machinery and doing considerable work.—The Volcano mine is under option to Cincinnati interests.

At Kingston, the Virginia, Sawpit, Snow Storm, and Lucky Strike mines are all being worked on a small scale. On the Bullion Hill property two adits are being driven.

Shipments of manganese ore continue from the mines at Boston hill, adjoining Silver City. The ore is sent to Chicago, Illinois.

The old Victorio mines at Gage are being opened again by El Paso capitalists. Andrew Bain is in charge of the work.

The Mogollon silver-gold district of Socorro county is regularly covered in the news section of the Press.

DEADWOOD, SOUTH DAKOTA

RESUMPTION AT THE PURITAN.—TUNGSTEN AND CYANIDING AT THE HOMESTAKE.—TROJAN, RELIANCE, HEIDELBERG, ORO HONDO, AND CUSTER PEAK MINES.

Work has been resumed at the Puritan mine, at the head of west Strawberry gulch. Operations are being undertaken by the New Puritan Mining Co., of which John McGoffin is general manager and John R. Russell secretary. Both are residents of Deadwood. Finances are coming from eastern South Dakota, where good crops and prosperous business conditions have been the rule for years past. The shaft has been sunk to a point below the quartzite, into the schists, and a cross-cut is being driven west to explore a mineralized territory disclosed in stopes above. The ore contains silver and lead—the latter in small quantities—and it is thought will make a good concentrate by flotation.

Tungsten production continues at the Homestake; in fact this company is the largest Black Hills producer of the black concentrate at present operating. The ore is hauled by teams from the workings on north Lead hill and delivered to a crusher near the Star shaft. After crushing, it passes to a belt-conveyor, from which the high-grade ore is hand-picked and the low-grade fed to a 5-stamp mill. In front of the battery is a short amalgamating-plate where some free gold is saved. Concentration is accomplished on a Willey sand-table and two Deister sliming tables. About 20 tons per day is treated. It is stated that the ore contains enough gold to reimburse the company for all expenditure of its milling and mining, thus leaving the tungsten concentrate as clear profit. A high saving of the gold-content is effected, as the tailing from the mill goes to the cyanide department.

Three additional tube-mills are to be installed in the fine-grinding plant at the Homestake. This will practically double the capacity of the unit, and permit of the grinding of all of the sand originating in the stamp-mills at Lead. Fine grinding has paid well at Homestake. In addition to the extra saving by amalgamation—the re-ground product passes over amalgamating plates—increased extraction has been noted at cyanide plant No. 1, where the sand is treated by leaching. The company's metallurgists endeavor to feed to this plant a sand product just as fine as it is possible to leach within reasonable time. The slime plant has long been noted for its high efficiency, so fine sand and slime are the products most sought for as feed for the cyanide department.

That the Trojan Mining Co. is going whole-heartedly into the treatment of custom ores is attested by the facilities being provided for their reduction. First is a three-rail railroad track convenient for either narrow or broad-gauge ore-cars of the C. & N. W. or C. B. & Q. On this track will be a scale for weighing the carload lots. From the cars the ore will drop to underground pockets and thence be led to a crusher, and next to a mechanical sampler; then will drop to underground bins—in reality old stopes—of several thousand tons' capacity. This equipment will cost somewhere between \$12,000 and \$15,000. This expenditure indicates that the company's officials have confidence in the district's ability to continue to produce ores amenable to cyanide treatment. At the mill, additional capacity will be secured by what will be almost a complete rehabilitation of the slime department. This will include a tube-mill, classifier, thickener, agitators, and a revolving-drum filter. The plant's daily duty is now about 350 ton.

M. C. Bowman, general manager of the Reliance up to the time of its closing in the middle of September, has gone to the Blsmarck mine, adjoining the Wasp No. 2, and hopes to be able to start that mill within a few months. The plant is well suited to the ores, i. e. conveniently situated to the mine, and it was demonstrated under former management that mining and milling could be conducted for a little under \$1.20 per ton. Thus a 75% recovery on \$3 ore, when 200 tons daily are treated, would result in a good profit being earned.

At the Heidelberg, what is probably the most important development yet recorded, was recently made when the west cross-cut encountered a vein assaying as high as \$40 to \$50 for about 18 in., and with wall rocks enriched to pay-ore for 5 or 6 ft. on each side. The cross-cut was continued through the ore and drifts driven a few feet in each direction. Effort is being made to find the vein on the surface. Eastern people have been given an option on 51% of the capital shares of the corporation, with the understanding that the entire amount of money will be spent under the supervision of the purchaser, in further development of the property. This is the ground that a few years ago was taken over by a syndicate of local people, encouraged by the Deadwood Business club, and on which something over \$15,000 of local money has been spent. Its success would do much to stimulate local interest in mining ventures.

Sinking is now under way at the Custer Peak copper mine, where at a depth of 250 ft. oxidized material was found in lateral work. The management intends to put the shaft down to the zone of secondary enrichment. Surface geology and mine developments to date seemingly indicate that a copper mine of merit will be uncovered. The company owns a large area, covering the vein for over 3 miles.

Sinking is again to be resumed at the Oro Hondo, this time with the 3500-ft. level as the objective point; the shaft is now 2000 ft. deep. In past months a great deal of diamond-drilling has been done. The additional sinking will make necessary the purchase of a large hoist, and in this connection it is expected that the top of the shaft, for 40 or 50 ft., will be concreted, and a new and higher head-frame, probably of steel, erected.

SUTTER CREEK, CALIFORNIA

THE STRIKE SITUATION AT THE END OF OCTOBER.

There appears to be little change in the strike situation (October 29), and with the exception of guards, pump-men, engineers, and a few shaft-men, all the large mines of the county, except the three who met the men's demands prior to the strike, are idle. The Northern Amador County Merchants Association has given its support to petitions now being circulated, by which many of the miners are expressing their willingness to return to work on the old basis. The local Union leaders declare that men returning to work or signing such petitions forfeit their Union membership, and reports are at variance as to whether any Union men are signing up. It was reported that 15 men returned to the South Eureka on Friday morning, and half as many to the Central Eureka, but this report proved untrue. Now, it is claimed that 30 or 40 men will resume work at the Bunker Hill mine on Monday morning, and that more are ready to return when satisfied that they will be unmolested by the strikers. It is claimed that so many men have left the county since the strike commenced on September 19, that all the mines will be short-handed even if a satisfactory settlement is arrived at. U. S. Deputy-Marshall Bohm is still here, and is said to have served at least fifty of the strikers with papers from the U. S. District Court restraining them from committing violence pending the hearing to be had in San Francisco on Monday, the 30th, when cause must be shown why permanent injunctions may not be issued. Some of the strikers have attempted to elude the Marshal and his deputies in the service of the papers, and others signify their contempt by tearing the documents to pieces as soon as served, but the Marshal appears tireless in his efforts to accomplish his purpose by use of both force and strategy, having for the men at unexpected places and even using "Jim Jones" once to "cock" a man to gather the fragments of the paper he had thrown to the ground and tramped upon. Denver officials of the Western Federation arrived here yesterday. Everybody is getting tired of the whole business and wishes that the strike were settled.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALABAMA

In Bulletin 640-1 of the U. S. Geological Survey, Edson S. Bastin describes the Gold Log mine near Talladega. The property had been worked intermittently for 70 years previous to the present owners acquiring it in June of 1915. E. A. Thomas is manager of the Gold Log Mining Co. The vein has been explored by an adit 250 ft. long, from which is an incline 320 ft. deep. Stopes average 6 ft. in width. The ore, in schist, consists of (1) irregularly interlocking white to light-gray quartz, white to pale-pink calcite, and minor quantities of sulphides and free gold; and (2) schist partly replaced by some or all of these minerals. The principal sulphide noted is chalcocite. A characteristic of the deposit is that wide shoots pinch out or decrease greatly within short distances. Water power drives the ten 750-lb. stamps, etc. Gold, averaging \$4 per ton, is saved on copper plates and blankets. Concentration is not attempted. The daily capacity is 25 tons.

ARIZONA

Some complaint has been made throughout Arizona mining districts to the effect that the smelters refuse to receive small ore shipments from the smaller shippers, says the Arizona State Bureau of Mines. There is a congestion of ore at all the smelting plants at present, which is the cause of the curtailment of shipments. However, many of the small operators, whose properties are under development, claim the smelters have not refused to treat the increased tonnage of the larger mines. The small operator, as a rule, depends on the sale of ore to enable him to advance his development, and when the only available markets are closed to him, he is severely handicapped. To make a prospect produce sufficient ore to pay for its development is a method that enhances the mining industry, and should be encouraged and not retarded. It would seem that some preference should be given those small producers whose output is incidental to development, and the marketing of which is essential to continuance of operations. The big producer is relied on to keep the smelter in operation, and it is easy to understand the good relations between the two; at the same time the growth of the mining industry depends on the coming-in of new producers, many of which have to pass through a difficult period of early development. To encourage the small ore shippers is to make possible the opening of new mines.

There is little doubt of the willingness of the larger mining companies to assist the small ore shippers in the development of their properties, but small shipments of ore, coming irregularly, so break up the routine of the smelter operation that naturally the smelters prefer large and regular shipments. The small shipment requires as much clerical work, computation, etc., to handle as does a large shipment, but nets the same margin. The fact that the smelters are already producing more metal than the refineries can handle practically allows them to choose, to some extent, their ores, but the Bureau has never yet seen the time when the smelters could possibly handle the ores of the smaller shippers, that they did not only throw open their doors, but came out and invited them to ship.

BISBEE. The Shattuck-Arizona mine is producing daily 550 tons of copper ore and 50 tons of lead ore. General conditions underground are good, with important developments on the west side. The output in September was 1,566,446 lb. of cop-

per, 26,928 oz. of silver, and 419 oz. of gold, giving a profit of \$260,028.

(Special Correspondence.)—Chloride is suffering from too much lot-jumping, the inevitable accompaniment of a rush into a new mining camp. Some of the choicest business property in town is being taken by the jumpers, and there seems to be no recourse except by violence. Gun-play is fairly frequent, but so far both parties to the dispute have refrained from making work for the coroner. It is feared that trouble will result unless some way is found to end the jumping. The trouble was invited by the high prices asked for town property, and the questionable title to much of it. Lots that sold for a few hundred dollars six months ago or less, are now held for several thousand dollars. One choice corner lot is being held for \$8000.

The local water company is preparing to make large extensions and improvements to take care of its rapidly-growing business. A new reservoir is to be built at the head of Tennessee avenue, overlooking the business section of the town, giving good pressure for fighting fires. The town is spreading in a southerly direction, and the water-mains have long since ceased to reach a large portion of the newly-built area, which has had to rely for its water supply on the time honored water-wagon.

The power-line being constructed is within five miles of Chloride and the gap is being reduced at the rate of about half a mile daily.

The Black Jack ore is now passing through the streets every day en route to the Needles smelter. An army of burros is engaged in packing this ore from the mine to what is known as Tramway Landing, where it is loaded on wagons that haul it to the railroad here.

Another property is to be started in the early part of this week; this is the Emerson, centrally situated and of considerable merit. E. M. Binds of Los Angeles recently reported favorably on it, and on his recommendation capitalists have taken it over.

Chloride, October 23.

GLOBE. Three blast-furnaces and two converters are working at the Old Dominion, yielding 40 to 50 tons of copper per day. As the International smelter at Miami cannot receive more concentrate at present, this product is stored at the mill. Several alterations are being made in the concentrating plant. A Diesel engine is to be erected near the A shaft. The daily output of ore is 1000 tons, one-third being smelted direct. The mine's flow of water is now under 6,000,000 gal. daily, a decrease due to the Arizona Commercial doing some pumping. The latter company has received a new pump for its 14th level, and another one is on its way. This will allow for sinking to No. 16. Monthly profits average \$47,000 from 420,000 lb. of copper.

MIAMI. The Porphyry Copper Co. has been organized by J. D. Coplen and others, with a capital of 1,500,000 \$1 shares, to develop 13 claims west of the Inspiration Consolidated mine. Some work has already opened carbonate ore.

At the Miami Consolidated, adjoining the Live Oak mine of the Inspiration Consolidated, a new two-compartment shaft is being sunk. Ore is also being extracted. The Star Drill Machine Co. of Akron, Ohio, is sending two large churn-drills for prospecting.

By improvements to its tailing ponds the Inspiration Consolidated will save a great deal of water.

ARKANSAS

EVERTON. Three or more good zinc mines have been opened in this district, a 150-ton mill is being constructed at the Marguerite mine, and a good future is expected for the area.

KINGDON SPRINGS. Erection records in mill building have been common of late, in the south-western zinc region, but the new 100-ton plant at the Beaty mine, owned by O. W. Killam of Locust Grove, Oklahoma, was put up in 18 days. The ore is high grade.

RUSH. At the Edith mine last week a 9-hour shift at the mill produced 31 tons of concentrate. The new 150-ton mill is working well.

CALIFORNIA

CERRO GORDO. Development of the rich lead-silver shoot in the Cerro Gordo Mining & Smelting Co.'s property continues, while zinc ore is being shipped to smelters.



IN THE SHADOW CREEK DISTRICT OF MADERA COUNTY, CALIFORNIA, 60 MILES FROM BISHOP, ALTITUDE FROM 8000 TO 10,000 FEET. THE WHITE ROCK IN THIS PICTURE IS THE MINERAL-BEARING ZONE, CONTAINING COPPER, LEAD, AND ZINC. TUNGSTEN (WOLFRAMITE) IS FOUND NEARBY.

GRASS VALLEY. Ten more stamps have been ordered for the Golden Center mine and twenty for the Allison Ranch mine, which is controlled by the former company. Erection of buildings is under way.

HEBOULT. At the electric smelter the Noble Electric Steel Co. has three furnaces in operation, making ferro-manganese, ferro-chrome, and ferro-silicon. The company receives its raw minerals from various parts of the State.

PLYMOUTH. The September output of the Plymouth Consolidated was as under:

Ore milled, tons	6,900
Value of gold	\$44,621
Working expenses	25,351
Development charges	6,717
Surplus	12,552
Other expenditure	8,628

The new hoist is almost in place. The club-house, which was presented to the town by the company, is proving of great social benefit to employees and others. Dwellings for the men have been built.

ST. LOUIS. For violation of the Caminetti act, which guards against depositing tailing from hydraulic operations in navigable streams, J. Conlan of St. Louis in Sierra county was fined \$50 last week by Federal Judge Dooling. Tailing from sluicing went into Slate creek, then to the Yuba and Sacramento rivers.

SOSORA. A cross-cut from a winze in the Omega mine has opened free gold and mineralized ore assaying from \$10 to

\$60 per ton. A wide shoot is expected, as above it was over 24 ft. across. Lange & Hussey are lessees from Ayers & Harter.

COLORADO

BOULDER. The Colorado Power Co. states that during September, Boulder and Gilpin county mines consumed 660,000 kw.-hr. of current, compared with 286,000 kw.-hr. in that month of 1915. Fully 68% of the increase is from the Boulder mines. The tungsten boom was mostly responsible, though gold and silver mines contributed.

For the sum of \$20,000, E. J. Lavino & Co. of Philadelphia bought four tungsten claims from R. Kermack and H. De Vries. The Tungsten Metals Co. has had a bond and lease on the property, and will continue to operate, and may eventually buy the ground from the new owners. New equipment is to be ordered.

LEADVILLE. An important discovery of gold-silver-copper ore is reported in the lower adit of the Fidelity Gold Mining Co. on Bull hill, in the Lackawanna district. The gold-content is 10 oz. per ton. A mill is to be erected in the spring.

Owners of the Tarsus mine on Yankee hill have opened on the 650-ft. level a shoot assaying 89 oz. silver, 14% lead, and 20% copper. Prospects for persistence are considered good.

PUEBLO. In its 24th annual report the Colorado Fuel & Iron Co. states that the gross revenue was \$25,626,606, an increase of \$9,018,566, or 54%. A good deal of mention is made of sociological relations of the employees.

IDAHO

ADAIR. Development of copper properties in the east Coeur d'Alene district continues unabated. Results at the Montana-Idaho and Richmond mines are satisfactory.

BURKE. The new east lead-silver vein in the Hecla mine has been opened for 850 ft. on No. 3 level. Above this a raise is up 600 ft. in ore. The grade is high, with only traces of zinc.

MURRAY. A trial of the re-modeled mill at the Golden Chest gold-tungsten mine proved satisfactory last week.

MICHIGAN

HOUGHTON. Nearly 1600 new men have been engaged by the Calumet & Hecla subsidiaries during the past summer, but it is said that the proportion of transient men is greater than before. Some Mexicans have been employed.

MISSOURI

JOLIEN. Prices for zinc and lead ores remained the same last week. The first cold spell of the season caught some producers unprepared, reducing the output. The yield of the Missouri-Kansas-Oklahoma region was 6125 tons of blende and 893 tons of lead, averaging \$65 and \$85 per ton respectively. The total value was \$479,732.

MONTANA

BUTTE. During the third quarter of 1916 the North Butte company produced 5,954,685 lb. of copper, 247,833 oz. of silver, and 1002 oz. of gold. The profit was \$587,424.

At a depth of 1000 ft. in the Butte & Zenith City a cross-cut has passed through two promising veins.

GRANT FALLS. Two of the five units at the Anaconda company's electrolytic zinc plant are yielding 60 tons of zinc daily, 10 tons above the calculated capacity. A bag-house, with 1440 bags, costing \$100,000, is being erected. This plant will collect lead fume from reverberatories.

SALTUS. At the beginning of next year the Tarbox company will commence ore shipments.

TROY. According to Robert Gregg, interviewed by the Northwestern Mining News Service, a brief review of activities around Troy will convince anyone that it is one of the coming important mining regions. There are hundreds of men em-

ployed at the different properties, and supplies and equipment are being sent in by the train-load. The attention of investors also is being attracted to the district, and engineers are scouring the country for miles around in search of promising holdings that are for sale.

NEVADA

BRISTOL. A number of Utah people are operating successfully at this place, which is 14 miles from Pioche. The ore contains lead, silver, and copper, and is oxidized to a considerable depth. J. M. Hill, of the U. S. Geological Survey, recently visited the district.

(Special Correspondence.)—Preparations have been completed for the building of a sampling plant at Jean, with a capacity of 200 tons per 10-hour day. It will be particularly devoted to sampling ore from Goodsprings and properties to the south along the Salt Lake Route. Utah people are financing the enterprise.

Operations have been resumed by the Dawn Mining Co., situated on the eastern slope of Potosi mountain. Some high-grade zinc ore has been uncovered, and developments will be pressed with an increased number of men. Albert Munzberock is superintendent.

The Boss Mining Co. is busy preparing plans for the new mill. The testing plant is operated steadily under management of M. Goodwin, and is making a satisfactory recovery of gold and platinum. The proposed mill will have a daily capacity of 10 tons. About 800 sacks of high-grade platinum ore is available for treatment, in addition to the regular mine product.

The Potosi is shipping approximately 1200 tons of lead and zinc ore per month, a considerable proportion of this being high grade. It is controlled by the Empire Zinc Co., and was inspected last week by the company's Western manager, C. J. Brown.

The Searchlight district is again receiving recognition from capital. At the Quartette much new work is going on, and it is reported that the New York owners are preparing to operate with 100 men. G. F. Cohan is preparing to resume at the Duplex.—The shaft of the Big Casino is being sunk an additional 100 ft. in concentrating ore of good grade.—Work is to be resumed at once by the Searchlight Mining & Milling Co.—Several other properties north and east of the camp are decidedly active.

A 42-in. vein of \$75 gold-silver ore has been encountered in the Carnation claim, El Dorado canyon, at a depth of 20 ft. Gold largely predominates. The Eldorado Empire, Wall Street, Eldorado Nevada, Cluff-Era, Enterprise-Rand, and a number of other claims are actively worked. A new camp, known as Nelson, is growing.

Goodsprings, October 24.

GOODSPRINGS. A dividend of 2c. per share will be paid on November 10 by the Boss company. Two shifts are working in the lower adit to get under the copper ore opened above.

SEARCHLIGHT. The Searchlight cyanide-plant in charge of N. H. Barton, is working to capacity, and making a good recovery on tailing from the Quartette stamp-mill.

TONOPAH. During the third week of October the district produced 9864 tons of ore valued at \$193,492. Some September yields were as follows:

Mine	Tons	Bullion, oz.	Profit
Belmont	11,904	201,474	\$93,936
Extension	9,545	171,179	64,896
Jim Butler	3,552	.....	37,107
Tonopah	8,095	150,780	62,779

The yield for the week ended October 28 was 9959 tons valued at \$195,202. Development at the Belmont continues entirely satisfactory.—From 950 to 1540 ft. in the Extension's Victor mine results are good.—Improvement is reported from the Jim Butler.—For the quarter ended August

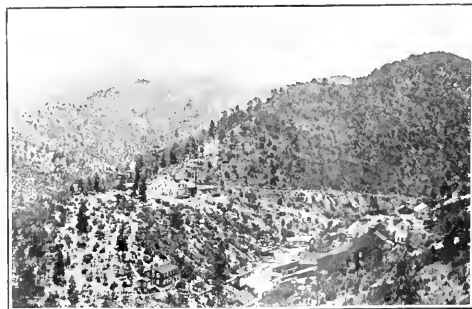
31, the Tonopah Mining Co.'s profit was \$122,713, plus \$44,604 from the Tonopah Placers Co. The dividend amounted to \$150,000. Cash on hand is \$36,172.

VIRGINIA CITY. The Mexican Gold & Silver Mining Co. has issued a circular in which it is stated that the last assessment levied on Mexican shares was nearly a year ago, on December 22, 1915. The discovery of ore in the Union Con., and the milling of the same in the Mexican mill, has netted the company a substantial profit, enough, in fact, to enable it to pay its pumping charges and explore the 2500 and 2700-ft. levels without calling on shareholders for funds during 1916. Exploration of the 2500-ft. level to the west has resulted in no discovery of importance. At 2700 ft. a well-defined formation has been exposed, showing every indication of being productive in depth. The pumps to lower the water from the present level (the 2700-ft.) to the 2900-ft. are now installed, and will start work probably about November 1, thus clearing the five north-end mines of the Comstock of water to the latter depth. The winze in the Mexican ground between the 2700 and 2900-ft. levels has been equipped with a hoist, and as the water-level is lowered exploration will be immediately commenced. It is firmly believed that something of importance will be discovered. Large quantities of mill supplies have been purchased and are now on hand, a single car of cyanide having been secured during the past week at a cost of over \$9000. In view of the steady increase of prices due to the War, and the difficulty of obtaining chemicals at all at critical times, this policy, it is considered, is fully justified, and will result in an ultimate saving to shareholders.

NEW MEXICO

On page 675 of this issue will be found a general review of mining in this State.

(Special Correspondence.)—Work has been resumed at the Gold Dust claims, situated in the south part of the district. The property has had 1800 ft. of adits driven, encountering



SCENE AT MOGOLLON, NEW MEXICO.

two orebodies. These are to be explored further and the main adit extended to the centre of the property.

Mr. Cockran, of A. Leschen & Sons Co., who is supplying material for an aerial wire-rope tram from the Pacific mine to the plant of Socorro Mining & Milling Co., is here, superintending installation. Rollers and rim work are being placed on standards and terminals; practically all the woodwork has been completed. The tram will have a length of one mile and a capacity of 10 tons per hour.

The Oaks Company is getting in supplies and other material preparatory to starting work on its drainage and transportation tunnel on Mineral creek. When completed it will be the largest and longest opening in the district, and will cut the principal orebodies at depths of 1400 to 1800 ft., and be the means of effecting a great economy in future operations.

It is planned to have a large capacity plant at the portal, and eventually centralize all metallurgical operations of the district at this point. The topography of the site is well adapted to the consummation of this scheme.

F. L. Ransome, of the U. S. Geological Survey, spent the week in camp checking geological work being done. An appreciable territory will have been covered when the area is completed.

Mogollon, October 17.

TENNESSEE

In the October 'Resources of Tennessee,' is a 23-page paper by W. C. Phalen, of the U. S. Geological Survey, on the conservation of phosphate rock in this State. Tennessee rock was first placed on the market in 1894. In 1914 Florida produced 78%, South Carolina 4%, and Tennessee 18% of the phosphate rock used in the United States and exported. The brown rock is the most important in Tennessee, occurring in Maury, Giles, Hickman, Lewis, and Sumner counties. The largest deposits are near Mount Pleasant in Maury county. They are termed 'blanket' and 'collar' deposits. Changes in methods of mining and preparation will leave little or no wasted rock in the ground. Clay, chert, and limestone must be removed before going to market. Overburden is removed by drag-line excavators and hydraulic lifting. Hand mining is much in vogue, due to the occurrence. The ore contains over 20% phosphoric acid and up to 70% phosphate of lime.

TEXAS

(Special Correspondence.)—Records of the Collector of Customs for the El Paso district show that there was a large falling-off in imports of ores and metals from Mexico through here during the first seven months of the current year, when compared with a corresponding period of last year. These imports for the period ended July 31, 1916, were as follows: January, gold ore \$2664, gold bullion \$17,827; February, ore \$2122, bullion \$10,705; March, ore \$10,631, bullion \$532; April, ore \$6857, bullion \$731; May, ore \$3250, bullion \$348; June, ore \$2348, bullion \$351. July, ore \$1029, bullion \$4116; making a total of \$28,931 gold ore and \$64,601 of gold bullion. During the same period of 1915 there was imported gold ore valued at \$69,950, and gold bullion worth \$1,188,305.

January silver ore imports were worth \$14,971, and silver bullion \$197,176; February, ore \$140,035, bullion \$1291; March, ore \$114,837, bullion \$20,300; April, ore \$45,607, bullion \$3790; May, ore \$29,041, bullion \$21,127; June, ore \$8445, bullion \$4222; July, ore \$11,186, bullion \$38,047; a total of \$361,423 of silver ore, and \$284,952 of silver bullion. During the first seven months of 1915 the silver ore imported had a value of \$472,172 and the silver bullion \$2,419,635.

Imports of copper ore amounted to 12,139 tons, valued at \$117,811. Last year, from January to July, inclusive, imports of the same product were 4995 tons worth \$86,395. Copper matte brought over this year was 683 tons, valued at \$12,021, while last year 798 tons was imported, worth \$35,642. This, the greatest movement of copper ores, took place in March, April, and May.

Imports of lead ores were as follows: January, 508 tons, value \$1753; February, 2212 tons, \$21,570; March, 6470 tons, \$36,512; April, 5948 tons, \$54,618; May, 3831 tons, \$19,843; June, 360 tons, \$1212; July, 812 tons \$4921; a total of 20,175 tons, valued at \$145,529. Last year from January to July, inclusive, imports of lead ores were 26,395 tons worth \$121,169.

Following is the record of zinc-ore importations by months: January, 30 tons, value \$972; February, 977 tons, \$4490; March, 3641 tons, \$122,096; April, 1349 tons, \$126,781; May, 2186 tons, \$55,578; and June, 5162 tons, \$110,766 (the figures for July are not available); total, 16,848 tons, worth \$450,892. During the same period of 1915 imports of zinc amounted to 12,699 tons, valued at \$182,218.

El Paso, October 23.

UTAH

ALTA. Progress in the Alta Tunnel & Transportation Co.'s tunnel is 8 ft. daily. Drilling in the limestone is a little easier lately. Results of this work are being watched with interest by the whole district.

MIDVALE. The new plant of the Midvale Minerals Co. costing \$100,000, to treat between 300 and 400 tons daily of lead-zinc tailing at the old U. S. smelter, has commenced treatment. Oil flotation is employed, using Janney cells.

PROMONTORY. At the United Promontory the shaft is down 128 ft. Samples of ore assayed 6% copper, 9 oz. silver, and 51% lead.

EUREKA. In our issue of October 14 we gave the total dividends of the Chief Consolidated Mining Co. at \$283,000; this should have been \$483,368. With the dividends that will be paid on November 2, of \$44,149, the total will then be \$527,518.

SALT LAKE CITY. Affairs of the Ohio Copper Co. are still in a tangle, resulting in much discussion as to its future, and proposed re-organization. On October 6 the International & Intercontinental Mining & Refining Corporation of 60 Wall Street, New York, sent a circular to shareholders. On August 30 the property was sold on foreclosure for \$750,000. The Corporation was unsuccessful in its application to postpone the sale, although the Ohio company was in a position to pay its debts and interest, and then have a substantial balance. The day following the sale the right to redeem the property was sold by the trustees in bankruptcy for \$40,000. Under the State laws the company had the right to redeem at any time within six months after the date of sale. The Stockholders' Protective Committee was being formed at the end of August and a re-organization plan was in preparation. Confirmation of sale in foreclosure and sale of the equity of redemption was adjourned to October 13, at which time the Court must be convinced that the stockholders intend to protect their own interests or the sale will doubtless be confirmed. At that date there would be the one chance for stockholders to save their property. On September 30, U. S. District Judge Manton granted the Corporation leave to intervene in the bankruptcy proceeding for protection of stockholders. The Judge pointed out that although the property sold for \$750,000, leaving an apparent deficiency of \$700,000, yet that deficiency has since been reduced to \$400,000 by royalties and rentals by lease of the property. He also commented on the non-paid stock, a valuable asset. Holders are urged to deposit their stock with the Central Trust Co. of 54 Wall street, New York.

WASHINGTON

REPUBLIC. Owing to the ore in the San Poil mine yielding only \$6.75 per ton, against \$8 expected, work has been suspended by the lessee, the West Hill Mining Co. of Spokane.

CANADA

BRITISH COLUMBIA

Silverton. The Standard Silver-Lead company pays 2½c. per share on November 10. The new orebody in the Alpha claim continues to open well. In No. 5 adit, 3 ft. of clean galena has been cut.

ONTARIO

COBALT. The Mining Corporation of Canada is operating its high-grade mill. It differs radically from the two other high-grade plants at Cobalt, in that amalgamation plays no part in the treatment, nor is the ore crushed in cyanide solution. The ore is first slined in tube-mill, and after a preliminary treatment in two stages is dewatered and washed on an Oliver filter, then given cyanide treatment, and again filtered and washed on a second Oliver filter. The silver is precipitated from the solution by sodium sulphide instead of aluminum dust, and the resulting silver sulphide precipitated, desulphurized, pumped to filter-presses, and refined in reverbera-

tory-furnaces to a high-grade bullion ready for shipment in bars to London.

LANGMUIR. The nickel deposits in this township have been optioned to the International Nickel Co., which will prospect by diamond-drilling.

PORCUPINE. During the quarter ended September 30, the McIntyre Porcupine Mines Co. made a profit of \$136,084. There was 35,810 tons of \$9.98 ore treated at a cost of \$4.93 per ton. Custom ore amounting to 6877 tons gave a profit of \$28,239, which is included above. Development covered 1062 ft. and 1302 ft. of drilling. At 1000 ft. depth the west drift on the boundary vein was advanced 300 ft. A stope above this level shows 8 to 30 ft. of \$15 ore. The present face is 18 ft. wide. Improvements at the main shaft will be complete early in January. Work from No. 4 and 5 shafts was satisfactory.

KOREA

The Oriental Consolidated reports the following returns for August: 200 stamps worked 29.9 days, crushing 26,895 tons. The gross receipts were \$132,660, and operating costs totaled \$76,722, and improvements, development, etc., cost \$1440, leaving a net profit of \$54,498.

MEXICO

CHIHUAHUA

(Special Correspondence).—At the Alvarado Mining & Milling Co.'s plant the labor is Mexican only. There are only two of the old American staff of the company at Parral, and they are operating five mines, and the plant of 400-ton daily capacity is working full time. The Mexican organization, however, is more efficient than was thought possible until the men were tried. All the staff left for El Paso in January last, after the Santa Isabel affair, and most of them returned in May, resumed operations in June, only to have to leave hurriedly again at the latter part of the month after the Carrizal affair. As the company did not desire to risk again the lives of its American employees, only the manager and another returned in July to resume operations. They found that the native help, after a period of near starvation, was willing to work, and the property has been running at full capacity ever since.

Villa has been active again in the vicinity of Chihuahua City, and there have been many rumors of his approach to attack Parral. It is hoped that he will confine his activities to the north and leave us in peace for a time at least. Conditions are bad, of course, and the entire State is under martial law, and executions are frequent. It seems that there is nothing to do but endure it until there is an end to the Wilson administration in the United States; that, more than any one thing, is considered to have caused these conditions to last as long as they have, with no hope for the future.

Parral, October 10.

The new mining and milling laboratory of the Haileybury School of Mines, Ontario, is nearing completion, and the institution is now getting its machinery and equipment. The laboratory will comprise a complete small-size concentrator, cyanide plant, flotation plant, assay-office, blacksmith, machine, and carpenter shops, and will contain most of the machines usually used in this work. The school has the co-operation of the companies in the Cobalt district and mining-machinery manufacturers, and is always pleased to make arrangements with manufacturers who wish to have their machinery represented in the plant.

The College of Mines and Engineering at the University of Arizona announces short courses for miners. Tuition is free to residents of the State, others pay \$1 per course. Prospectors have five weeks, starting on October 30, field geology two weeks from December 4, assaying ten days from January 3, metallurgists three weeks from January 15, flotation one week from February 5, and miners 6 weeks from February 12.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

DEANE P. MITCHELL is at the Palace.

WALTER STRACHE sailed for Chile on October 21.

GEO. WATKIN EVANS has returned to Seattle from Alaska.

PIERRE BOUCRY has left Alaska to give his services to France.

HALLET R. ROBBINS has returned from California to Vancouver.

WILLIAM DeL. BENEDICT has returned to New York, from California.

FORBES RICKARD has gone to Lovelock, Nevada, on his return from Arizona.

THEODORE HOOVER arrived in New York on the *Philadelphia*, on October 29.

PHILIP ARGALL passed through San Francisco from New Mexico to Denver.

DAVID T. DAY, of the U. S. Bureau of Mines, was in San Francisco this week.

FRED B. ELY has recently visited New York and has left for Vancouver, B. C., to remain indefinitely.

H. E. WEST has returned to San Francisco, and is with the firm of Hamilton, Beauchamp & Woodworth.

J. H. RICKARD is on his way back to Cornwall, from San Francisco, by way of Vancouver and New York.

EDWARD B. DUGHAM has been engaged as superintendent of construction for the Mammoth Copper Mining Co., Kennett, California.

J. N. BULKLEY, of New York, has been appointed consulting engineer to the Kaolin Products Corporation, and will design and supervise the erection of its new plant.

H. W. ALDRICH, superintendent of the leaching plant at Anaconda, has been promoted to superintendent of the blast-furnace and briquette plants; H. J. MAGUIRE succeeds Mr. Aldrich.

F. K. BRUNTON has resigned from the staff of the A. S. & R. Co. at Garfield, Utah, to accept a position as assistant superintendent of the Consolidated Arizona Smelting Co. at Humboldt, Arizona.

JOHN V. N. DORR has been awarded the John Scott medal by the City of Philadelphia, acting on the advice of the Franklin Institute, for the invention of his classifier, thickener, and agitator.

EDWARD A. STEINBERG, recent foreman of the United Comstock Pumping Association, who was injured July 4 in Virginia City, and has been confined to the hospital in Reno, has been removed to the Saint Francis hospital, in San Francisco, for treatment by a specialist.

GEORGE S. RICE, chief mining engineer, and H. M. WOLFLIN, mine-safety engineer, of the U. S. Bureau of Mines, were in San Francisco from October 25 to 28, for the purpose of arranging for a successor to EDWIN HIGGINS, who has resigned as the representative of the Bureau of Mines in the California co-operative work and as chief mine inspector of the Industrial Accident Commission. Mr. Wolflin was first assigned to this work in 1914, and he conducted the preliminary investigation that led up to the adoption of the Mine Safety Rules by the Industrial Accident Commission. Conferences were held with WILL J. FRENCH, commissioner, and Messrs. Rice, Wolflin, and Higgins, the result of which was a decision temporarily to assign Mr. Wolflin to succeed Mr. Higgins until such time as the plans discussed can be gone over with the Director of the Bureau and a permanent assignment made. Mr. Rice left for Los Angeles on the 28th and will return to Washington about November 15 stopping en route at various mining centres where the Bureau of Mines is conducting field investigations.

THE METAL MARKET

METAL PRICES

San Francisco, October 31.

Antimony, cents per pound.....	14.00
Electrolytic copper, cents per pound.....	29.25
Pig lead, cents per pound.....	7.25—8.50
Platinum: soft and hard metal, per ounce.....	\$90—94
Quicksilver, per flask of 75 lb.....	\$80
Spelter, cents per pound.....	12
Tin, cents per pound.....	43
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, October 31.

Antimony: 50% metal, per unit.....	\$1.25
Chromite: 40% and over, f.o.b. cars California, per ton.....	13.00—16.00
Magnetite: crude, per ton.....	8.00
Manganese: 50% (under 35% metal not desired).....	11.00 and up
Tungsten: 60% WO ₃ per unit.....	17.00

At Boulder, Colorado, the tungsten ore market is active, the price being steady at \$17 per unit for standard grades.

New York, October 25.

Antimony: Ore of good quality has sold at \$1.30 per unit in small quantities.

Tungsten: European consumers continue to inquire, but the market has been quieter in regard to actual sales, probably not more than 150 tons having been taken in the week. The nominal quotation is \$17 per unit.

Molybdenite: But little of this ore is available, and there is keen competition for what there is. Quotations are higher at \$1.70 to \$1.80 per lb. for molybdenum sulphide.

EASTERN METAL MARKET

(By wire from New York.)

October 31.—Copper producers are firmer and fairly active, near-by metal is scarce; lead is quiet and firm; dealers buying stragglers spelter.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Oct. 25.....	67.37
" 26.....	67.37
" 27.....	67.37
" 28.....	67.62
" 29 Sunday.....	67.62
" 30.....	67.75
" 31.....	68.12

Monthly averages

	1914	1915	1916		1914	1915	1916
Jan.	57.58	48.85	56.76	July	51.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	51.35	47.11	66.07
Mch.	58.01	50.61	57.98	Sept.	55.75	48.77	68.51
Apr.	58.52	50.25	61.37	Oct.	51.12	49.49	67.86
May	58.21	49.87	71.27	Nov.	51.19	51.88	....
June	56.43	49.03	65.04	Dec.	49.27	55.31	....

Steadiness and a slight rise is noticeable during the week, backed by a good undertone. The effect of selling from China is felt at times, although the actual amount of silver that changes hands may not be large, for there is always a possibility of the quantity increasing. The mere fact of China assisting with supplies influences other selling, speculators are disposed to take profits, and the Indian Bazaris, whose adverse views as to the future of silver are notorious, at once feel depressed. In these circumstances a certain retrogression in prices (as last week) is a natural outcome.

Silver worth \$125.100 was shipped from San Francisco to the Orient on October 28.

Silver stored by the Tonopah Mining Co. is worth \$131.011, calculating at 50c. per ounce.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Oct. 25.....	28.50
" 26.....	28.50
" 27.....	28.50
" 28.....	28.50
" 29 Sunday.....	28.50
" 30.....	28.50
" 31.....	28.50

Monthly averages

	1914	1915	1916		1914	1915	1916
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.28	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.61	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	....
June	13.60	19.75	27.47	Dec.	12.75	20.67	....

Thirty-cent copper is soon to be reported, according to some producers. Prices have stiffened of late. Smelting and refining companies are 600,000 lb. behind with deliveries of metal.

Dividends paid by 11 copper companies during October totaled \$5,772,181, on 3,233,117 shares. In September, 16 companies paid \$24,000,000 on 12,000,000 shares. Greene Cananea pays \$2 per share on November 27.

The American Brass Co., a large consumer (400,000,000 lb. annually) of copper is paying 10% for the last quarter of 1916, making 25% for the year, equal to \$3,750,000 on the capital. By the end of this year the surplus will probably be \$100 per share.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Oct. 25.....	7.00
" 26.....	7.00
" 27.....	7.00
" 28.....	7.00
" 29 Sunday.....	7.00
" 30.....	7.00
" 31.....	7.00

Monthly averages

	1914	1915	1916		1914	1915	1916
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	....
June	3.90	5.75	6.88	Dec.	3.80	5.34	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Oct. 25.....	10.25
" 26.....	10.25
" 27.....	10.25
" 28.....	10.25
" 29 Sunday.....	10.25
" 30.....	10.25
" 31.....	10.37

Monthly averages

	1914	1915	1916		1914	1915	1916
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	5.95	19.93	Aug.	4.75	14.17	9.42
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	....
June	4.84	22.20	12.85	Dec.	5.40	16.75	....

Value of ore production of the Missouri-Kansas-Oklahoma zinc-lead region for 12 weeks is now \$700,000 above that of the whole of 1915, namely, \$26,038,650. The present price of ore is stronger at \$10 per ton for 60% metal-content.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Oct. 3.....	75.00
" 10.....	78.00

Monthly averages

	1914	1915	1916		1914	1915	1916
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.00	60.00	39.00	Aug.	30.20	34.37	38.88
Mch.	39.00	78.00	21.90	Sept.	32.10	33.12	36.66
Apr.	38.30	71.50	141.60	Oct.	30.40	33.00	....
May	39.00	75.00	90.00	Nov.	33.50	39.50	....
June	38.60	90.00	71.70	Dec.	33.60	38.71	....

This is firm at 42 cents.

TIN

Prices in New York, in cents per pound.

	1914	1915	1916		1914	1915	1916
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.00	60.00	39.00	Aug.	30.20	34.37	38.88
Mch.	39.00	78.00	21.90	Sept.	32.10	33.12	36.66
Apr.	38.30	71.50	141.60	Oct.	30.40	33.00	....
May	39.00	75.00	90.00	Nov.	33.50	39.50	....
June	38.60	90.00	71.70	Dec.	33.60	38.71	....

Eastern Metal Market

New York, October 25.

The feature in copper is a persistent and general rumor that a foreign country, presumably Italy, is negotiating for a large quantity. Meanwhile the undertone of the market is strong.

Zinc has reached and passed 10c., although the upward movement now appears to have halted. A heavy business has been done in the past few days, principally with the galvanizers.

Lead is stronger in the West, but obtainable at Eastern points at 7 cents.

Tin is higher despite a quiet market.

Antimony is dull again.

Iron and steel prices continue to advance. In a broad way it may be said that prices of semi-finished steel are \$15 to \$20 per ton higher than a year ago, and those of finished materials, \$20 to \$30 higher; and it is highly probable that higher levels will be reached.

The pig-iron market has been highly excited this past week, and quotations have jumped from \$1 to \$3 per ton. The coke market is even more agitated, sales of prompt foundry and furnace coke having been made at \$6 to \$7 per ton, with nearly \$8 asked. The car shortage has interfered with deliveries of contract coke, and consumers have been obliged to buy spot fuel. Thousands of tons of shell-steel are still under negotiation.

The metal-working machinery trade is near a normal basis in all save prices. The builders and dealers in machine-tools have been in convention in New York this week, devoting much discussion to *post-bellum* possibilities in their line. The dealers point out that prices must be lower if they are to successfully combat the flood of second-hand machines that the munitions' makers will place on the market, and compete with the new and cheaper machines which the War brought into being. It is estimated that 100 more firms are now making machine-tools than were in the business two years ago.

ZINC

Early last week it was remarked that the producers had set their minds on obtaining 10c. for spelter, and in the face of a fairly good demand they appeared unwilling to sell. However that may be, the fact is that the price has reached and exceeded 10c., also that in the past four or five days an extremely large tonnage has been bought, mostly of the galvanizing grades. The brass mills have shown little interest. Spot was quoted yesterday, the 24th, at 10.25c., New York, and 10c., St. Louis, November at 10.12½c., New York, and first quarter at 9.87½ to 10c. The market showed an advancing tendency until yesterday, when it halted, much to the disappointment of the sellers. The London spot quotation yesterday was £54, or £1 higher than a week previous. Exports continue on an enormous scale, those of the month up to the 25th, amounting to 7027 tons. Sheet zinc is unchanged at 15c., carload lots, f.o.b. mill, 8% off for cash.

LEAD

Considerable business has been done in what the trade terms chemical lead, in contra-distinction to desilverized lead in the St. Louis district. About October 18, when the St. Louis quotation of the independents was 6.85c., large quantities of chemical lead were taken at St. Louis, with the result that all grades advanced to 6.92½c. in that territory where they have since remained. In the East, however, good brands have been obtainable at 7c., New York, the quotation to which the A. S. & R. Co. has adhered. The big interest has been quoting 6.92½c., St. Louis, for some time. In New York dealers have quoted up to 7.25c., for strictly spot metal. It is reported, and the trade is puzzled thereat, that the A. S. & R. Co. has been a buyer of lead of late. Last week a good export busi-

ness was done, largely on Canadian account. Exports from the 1st to the 25th totaled 2871 tons. The London quotation yesterday stood at £30 10s.—unchanged from a week ago.

COPPER

Rumors are current that negotiations are under way which may lead to a large sale to one of the European nations, probably Italy. No details are available at this writing, but the rumor is so generally diffused that it probably has a basis of fact. It has given the market a better undertone, though prices have not actually advanced. Spot electrolytic is quoted from 28.75 to 29c., November at 28.50c., December at 28c., January at 27.50c., first quarter at 27.25c., and first half at 27c. The producers of choice Lake are said to be sold-up until next March, for which position they quote 27.37½c. Arsenical copper is obtainable for near-by delivery at 28.50c. Practically all of the spot metal is in the hands of second-hands. The general aspect of the market is one of quiet, verging on dullness, and not much change is expected until the political situation is somewhat cleared-up. The demand for brass and copper products continues extremely heavy. Large inquiries for copper shell rings are in the market, but none of the makers can take on any more of this kind of work. If they could they could easily get orders for millions of rings. The London market is stronger at £144 for spot electrolytic, against £143 a week ago. Exports from October 1 to 25 totaled 21,681 tons. For the first nine months of the year they were 245,002 tons, compared with 186,663 tons in the same period of 1915. In this period the exports were apportioned as follows in long tons, by Secretary Mayer of the New York Metal Exchange:

	1916	1915
United Kingdom	57,454	60,458
France	118,121	68,915
Holland	2,086	947
Italy	35,405	31,415
Denmark	2,704	1,711
Norway and Sweden	8,101	12,134
Russia	18,030	9,171
China and Japan	71	108
Sundries	3,030	1,804
Total	245,002	186,663
Total exports in 1915 amounted to 276,344 tons.		

TIN

At no time since the last report has there been any great activity in the market, although in the last half of last week buying was steady, if moderate in total volume. The quotation yesterday for spot Straits was 41.25c., with spot Banca at 40.87½ to 41c. Banca has been surprisingly steady, and has held close to the quotation for Straits. Permits to ship from England are again more difficult to secure, and this has had a stiffening effect on the market here. Arrivals this month total only 2065 tons, and it is felt that the monthly statistics will show a substantial reduction in stocks. The quantity afloat is 2025 tons. In August imports of tin at Pacific ports totaled 313,902 lb., valued at \$124,329 in the San Francisco district, and 941,321 lb. valued at \$378,373 in the Washington district.

ANTIMONY

Again the market can only be reported as dull, with Oriental grades at 13 to 13.50c., duty paid. Considerable business was done on Canadian account a few days ago in metal required for shrapnel bullets. Needle antimony is quoted at 11 to 11.50 cents.

Company Reports

ORIENTAL CONSOLIDATED MINING CO.

As usual, the 36-page report of this American company operating in Korea, contains much of interest. The following notes are from the remarks of the general manager, Alf Wellhaven:

From 309,730 tons of ore treated, total receipts were \$1,636,300, equal to \$5.28 per ton. All costs amounted to \$2.91 per ton. After paying for development and construction the profit was \$677,820. Three dividends of 50c. each absorbed \$644,080.

The following table gives some details of the mines:

Name	Development, feet	Production, tons	Average value	Reserves, tons
Tabowie	13,000	126,766	\$6.73	560,000
Taracol	12,798	104,957	4.64	210,000
Chintul	4,321	25,968	1.15	20,000
Tongkol	981	7,472	7.56	7,000
Charabowie	2,636	43,723	8.17	45,000
Candlestick	2,878	1,704	7.64	.....

The average cost of mining was \$1.79 per ton, including development. Results of exploration were satisfactory in the Tabowie, Taracol, Tongkol, and Chintul mines. The future of the Charabowie and Candlestick is not bright. On outside properties a total of 3740 ft. of prospecting was done, with poor results.

Some mill details are as under:

Name	Stamps	Ore crushed, tons	Bullion, tons	Concentrate, tons
Tabowie	80	4.59	126,766	13,856
Taracol	80	4.97	137,537	294,309
Maibong	40	3.12	43,723	2,264
Candlestick	19	3.39	1,704	9,368

Cyanide plants gave the following:

Name	Concentrate treated, tons	Value	Recovery, %
Taracol	26,281	\$66,023	85.6
Candlestick	1,704	3,648	64.6
Maibong	2,264	51,136	91.2

The total extraction in bullion and concentrate was 90.2%. Milling expenses were 47c. per ton, a decrease of 1c. Recovery at the Taracol cyanide plant was 1.7% higher and cost 1c. lower; at the Maibong tube-mill plant the recovery gained 20.3% and the cost was lowered \$1.79 per ton. Some slag bullion was included, so the 94.2% may not be maintained. Concentrate treatment cost \$1.99 per ton of concentrate, or 19c. per ton of ore. The assay-office made 41,198 determinations at a cost of 13.16c. each.

The report contains notes on construction, cordwood railways, forestry, hydro-electric power developed (130 hp.), rainfall (76.1 in.) machine-shops, transportation, bullion expense, geological examination, medical, tree bath-house for native employees, and bonus of \$10,000 for white employees.

The output to date is \$25,743,213 from 4,141,397 tons of ore, and dividends totalling \$7,069,860, or \$10.50 per share.

The crest of a single anticlinal fold of a vein is held to be a sufficient apex to sustain an extra-lateral right thereon. A terminal edge on the vein held not to be necessary in order to constitute an apex.

Jlm Butler Tonopah Mining Co. v. West End Consolidated Mining Co. (Nevada), 158 Pacific, 876, July 3, 1916.

Note: This decision was discussed fully in our issue of July 22, 1916, and has since been taken on appeal to the United States Supreme Court.

Book Reviews

HANDBOOK OF ROCK EXCAVATION METHODS AND COST. By Halbert P. Gillette. P. 825. Ill., index. Clark Book Co., Inc., New York, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$5.

The author of this volume needs no introduction to the engineering profession, for his books on 'Cost Data' and 'Cost Keeping and Management Engineering' have long been standard works. This is the first of three books which are intended to cover the subjects of rock excavation, earth excavation, and tunnels and shafts. In the book under consideration there is much descriptive matter of the machines and devices employed, especially the different types of drills, steel, and bits. The subject has been divided under the general head of machinery, drilling operations, explosives, blasting methods, loading and transporting the broken rock. The application of methods and the cost are given with concrete examples of each type of work in mines, quarries, railroad cuts, canals, trenches, and sub-aqueous excavations. Considerable space has been given to the discussion of steam, compressed-air, and other power-plants, considering the cost of installation and relative efficiency of each type. There is described such a wide range of conditions of work that the engineer can scarcely fail to find in this book data on operations closely analogous to his own individual problem. The diversity of subjects treated makes it valuable to all branches of the engineering profession. The flexible leather binding and pocket size adds convenience to its usefulness.

THE MINERAL INDUSTRY, DURING 1915. Edited by G. A. Roush. Vol. XXIV. P. 941. Ill., index. McGraw-Hill Book Co., New York, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$10.

While appearing a little later than usual, and considering that the War has interfered with the collection of foreign data, those who make use of this annual compilation on the statistics, technology, and trade of the world's mineral industry will find that it is as valuable as ever. Forty-eight specialists covered 55 metals and minerals. Since the conflict in Europe started and the normal condition of the world's mineral business was greatly curtailed, American prospectors, engineers, metallurgists, and ore dealers have had a busy time on account of the shortage of many products, discoveries of important minerals, finding new markets, devising treatment, selling at high prices, and settling down to new conditions. Queries on all subjects have been sent, in great numbers, to the trade, technical journals, and others, the U. S. Geological Survey receiving up to 1000 a week. The changes in conditions in each important commercial mineral or metal are recorded in the work under review. The War created an enormous demand for base metals, for export, apart from better domestic demand; on the other hand, it prevented the importation of many vital minerals that enter into manufacture of special materials. Aluminum, antimony, chromium, copper, iron and steel, lead, manganese, nickel, oils, phosphates, potash, sulphuric acid, tin, tungsten, vanadium, zinc, and others are discussed from the trade's point of view and improvements in metallurgical practice. Abstracts are given of the important articles appearing in the technical press; in fact, there is so much information that it is impossible to attempt to go into detail. Progress in ore dressing is a valuable summary. A new chapter, and one demanded by its great importance, is that of 35 pages on concentration by flotation. The previous chapter on ore dressing also contains a good deal on flotation but the two writers do not overlap to any extent. We note on page 776 and 828 similar cuts of the Anaconda mill, also a few typographical errors on other pages, though not serious. Eighty-one pages of statistics complete a useful and well-prepared book of reference.

EDITORIAL

T. A. RICKARD, Editor

PLATINUM has risen to \$100 per ounce for soft metal, the rise caused by the War being accentuated by holiday requirements. This also is a factor in improving the demand for silver.

COST of living continues to increase and is now close to the 200-mark, as against 140 a year ago. National prosperity is being heavily discounted. The rise in the price of flour and potatoes is more real to most people than the soaring of stock quotations.

EIGHTY per cent of the copper to be produced in the United States during the first half of 1917 is said to be sold in advance. This would indicate that 900 million pounds of copper has been placed for delivery during the first six months of the coming year, the refinery yield being estimated at 185 million pounds per month. At 26 cents this half-yearly output of copper would be worth \$235,000,000. Even that does not cover all the business in the metal for forward delivery, some consumers looking even farther ahead.

MILLS and machinery are capable of expanding in capacity to a remarkable degree. At the Utah Copper plant formerly rated at a capacity of 20,000 to 22,000 tons is treating 36,000 tons daily. The stimulus of high prices has increased the output of men and machinery everywhere. The Utah Copper mine is credited now with an earning of \$1,000,000 per week, including its 51% interest in the Nevada Consolidated. Speaking in millions, it is interesting to note that the Anaconda has now attained a smelter capacity of 1,000,000 pounds of copper daily. There, as elsewhere, the hurry to make the most of the favorable market is tending continually to increase the cost of production. When the War ends, there will be a big readjustment in technical methods in the effort to return to a lower basis of cost.

GOOD news comes from the Mother Lode region. The strike is over. It appears that the action of the Federal Court and the importation of men from the outside proved decisive, but the basic reason for the collapse of the strike was the recognition of the fact that there was no real reason for it, none except the usual attempt of the Western Federation to incite trouble. We note that the dividend-paying condition of two large properties was held an excuse for demanding higher wages. The men do not know how much money has to be put into a mine before it becomes profitable, nor do they know how much is spent long after dividends have been

suspended. The failure to publish statistical information on these matters furnishes the labor agitator with the chance to tell yarns and to lay stress on the temporary richness of a mine. While the operators on the Mother Lode have made money, they have made no such clean-ups as those engaged in copper mining; many of them have taken the dividends from one mine to prospect or re-open another property in the same district. Just now gold is in a depreciated condition as measured in supplies and machinery; this is no time to harrass the owners and operators of gold mines.

WE note a change in the editorial control of our London contemporary *The Mining Magazine*, the October issue appearing under the flag of Mr. Edward Walker, formerly assistant-editor. He succeeds Mr. H. Foster Bain, whose short tenure of the editorship is ended by the acceptance of an appointment in China, whither he is now sailing. We congratulate Mr. Walker and the readers of the magazine. Mr. Walker has fully deserved his promotion, for he is responsible for much of the careful work that enabled our contemporary to achieve a rapid success when it was started seven years ago. We do not even demur to the remarks made by *The Financial Times* that "in these unprecedented times it is particularly appropriate and satisfactory that the editorship of such an important publication should revert to English hands and also that a well-known and highly respected London mining journalist of purely British antecedents should have become associated with the management." The concluding clause in this quotation refers to the transfer of Mr. Edgar Rickard's interest in the *Magazine* to Mr. W. F. White, who has been honorably identified with *The Mining News*, a small but clean commentator on mining affairs in London. We wish the new management every success.

MEXICAN affairs proceed in the usual way. Now that the presidential election is over, we may expect to hear from the Joint Convention, which has been holding lengthy conversations in the salubrious air of Atlantic City. We do not expect any practical result from these debates. The Mexican position cannot be remedied by talk. Meanwhile Villa, or the substantial ghost of that villain, has been making the *de facto* Government of Mexico look foolish, if it needed his depredations to do so. By the capture of Santa Rosalia and Parral, and by his incursion upon the city of Chihuahua, he has shown what a weak hold Carranza has on the northern region. Trustworthy news is hard to get, much of it having been manufactured recently in order

to influence our presidential election. So far as we can learn, the Carranza government is making no real progress in pacifying the country or in restoring the semblance of order. Despite the political chaos our operators and engineers are returning to their mines, hoping against hope that somehow they will be enabled to work their properties even though their own Government refuses to protect them.

THIS week discussion begins with a sensible letter from Mr. Joseph Ralph, a widely-traveled engineer, who lays stress on the fact that the nomadic professional man cannot take a big load of books with him and must perforce restrict his literary baggage to a few essential handbooks. Mr. Fred. B. Ely, a mining engineer that knows the economic value of geology, discourses on geologic theories and the danger of generalizations, giving specific examples of conditions modifying the distribution of ore in the rocks. Mr. Charles F. Willis, in his capacity as Director of the Arizona Bureau of Mines, takes objection to sundry remarks of ours, for which we do not apologize, but we are glad to give him the chance to explain his position. Finally we insert a note on the use of the Hardinge ball-mill at Miami.

Base Metals After the War

Discussion concerning things that will happen "after the War" is a pleasant pastime if for no other reason than that it permits us for a while to imagine the world normal again. Whether the wish be only father to the thought or whether the sizes multiply that there is to be an end shortly to "the pentecost of calamity" we cannot affirm, but we shall talk with our readers on a matter of commercial import, namely, the effect of peace on the price of the base metals. In doing so we accept the aid of an excellent address on the subject delivered by Mr. Charles S. Trench before the recent annual convention of the National Hardware Association. Mr. Trench acknowledges that no confident prediction is possible so long as there is uncertainty concerning the duration of the War and the nature of the ultimate decision, but he argues that we can assume that when the change to peace does come the United States will face it with an overflowing pocket book, that the recent advance in the price of the metals has not been the result of speculation, that we have accumulated no surplus stocks, and that while the War lasts both our domestic consumption and the demand for metals from Europe will continue. The chief danger is that peace will find us with a production in excess both of our own requirements and those of Europe. Any abnormal level of prices is sure to undergo unpleasant adjustment, as has been already foreseen as regards antimony and spelter, both of which have dropped far from the speculative price of a few months ago, the first falling from 15 cents per pound to 9 and the second from 27 cents per pound to 24. It is generally recognized that any metal that is doomed to the last lap will be in danger of a violent collapse when hostilities

cease. But while we may all agree that the first assurance of peace will upset the metal markets, as the declarations of war did in 1914, we have yet to consider what will happen when the shock is over and the so-called civilized world faces a new set of conditions. To that we now come. The Allies have been accumulating stocks of metal, and they are likely to continue the process of accumulation, largely by purchase from us. They realize the possibility that this source of supply may be cut off either by the United States becoming a belligerent, by an interruption to trans-Atlantic transport, or by the placing of an embargo on American exportation. Should the War cease soon these stocks would menace the market. The Central powers are believed to be short of some metals, notably copper, but large purchases of that metal are reported to have been made on German account for delivery after the War. We may expect a sudden halt in the European demand unless the cessation of hostilities is treated merely as an interval preparatory to a resumption of the conflict and the replenishment of munition supplies. Turning to the specific metals, it will be well to compare prices today with those just before the War, and with the average of the 30 years before that.

	Average of 30 years before the War	1912-1913	November 1, 1916
Copper	14.06	16.00	28.50
Lead	4.25	4.44	7.00
Zinc	5.36	6.45	10.27
Tin	27.63	45.37	41.00

Tin has suffered from the War, for it is an essentially peace metal; ocean transport has been so costly as to interfere with shipments, production is not increasing, stocks are low, and the end of the War will see a rise due to the need of the metal in Europe, as well as the increasing consumption in this country. The United States produces no tin worthy of statistical mention, and it is quite possible that England may place an export duty on the tin produced in her dominions. Lead has doubled in price since October 1914, this increase stimulating our domestic production. The use of it in munitions has played an important part. The protective tariff on this metal will not help the miner, as we are producing considerably more than we consume. Therefore a decline is certain, because export trade will diminish.

Zinc has had a good time during the War, rising from 4½ to 27 cents per pound during the first year of hostilities. The high price reflected the insufficiency of supplies, caused largely by the cessation of production in Australia, due to the loss of smelting facilities when the Belgian refineries were closed and the German plants became inaccessible. The price of 10 cents today represents not so much the scarcity of metal as the increased cost of production, which is probably about 7 cents, owing to higher wages and the greater expenditure for materials. Before the War, Europe smelted twice as much spelter as the United States, and three-quarters of the European output came from Belgium and Germany. Great Britain contributed only 55,000 tons, although

that country consumed 200,000 tons per annum, this being also the amount produced in Australia. During the current year the British government has awakened to the logic of the position and has taken steps to stimulate domestic smelting, so that plants capable of producing 100,000 tons per annum are now assured. Formerly our exports of spelter were negligible, being balanced by small imports of zinc ores from Mexico and elsewhere; therefore we had no say in the world's market for spelter, which was completely under the control of the German cartel. Since the War the domestic demand has been enormous, to make brass for binding shells and for other warlike purposes. The number of retorts in blast has been nearly doubled since the end of 1914, representing an increase of production equal to 350,000 tons of spelter per annum, as against an actual output of 346,676 tons in 1913. Besides this there is the production of electrolytic zinc, which is destined to prove an important factor in regulating the price. At the end of this year there will exist the plant for producing 900,000 tons of spelter per annum. The production in the first half of 1916 was 267,696 tons from domestic ores and 50,000 tons from imported ores, mostly Australian. Exportation will not cease when the War ends, but there is bound to be a severe decline, besides a heavy shrinkage of consumption by the brass trade in this country. A complete re-organization of the spelter business is inevitable. The high cost will compel many retort-plants to close-down as soon as the price of the metal responds to the slackened demand. Many of the existing smelters can go out of business cheerfully, having paid for themselves several times over, and the survivors among the retort-smelters will have to face the competition of the higher-grade electrolytic zinc, which will dominate the market. There lies the hope of the industry, for if electrolytic zinc of 99.98 purity can be made for 4 cents or thereabouts there will be a chance for the galvanized trade to expand and for the miner to make money out of zinc even after the War.

Copper is the most important of the base metals and the one playing the greatest part in the economies of war. The outlook for this metal is cheerful. Evidently the British and French governments believe that copper will be in great demand for some time to come, otherwise they would not have contracted for 448,000,000 pounds at 26 cents for delivery in 1917. Normal consumption in the world increases 7% per annum; that in itself is a potent factor. It is true our domestic production promises to be 900,000 tons this year, as against 600,000 tons in 1913, and within a few months we shall have a refinery capacity of 1,200,000 tons per annum, but even before the War our consumption was as high as 400,000 tons, and under prosperous conditions we could now consume fully 500,000. Our export for several years before the War averaged 350,000 tons annually, of which 100,000 went to Germany. In 1913 the preparation for war caused Germany to import 153,500 tons from us. There is reason to believe that in that country all the stocks of copper have been used and that the Central powers will

be bare of the metal when peace supervenes, despite the saving and re-using of the reject from munitions. All the copper utensils, roofing, and wire that have been melted will not be replaced at once, of course, but there should be a heavy demand for our copper from that part of Europe. A decline, of course, there will be, and the first effect will be to curtail production automatically, the copper of many mines being won at a cost that will prove in excess of the market price. If the average cost of American production was 10 cents per pound before the War, it is now probably about 12 cents. Even the big low-grade properties are being worked extravagantly in order to make the most of the extraordinary market; in a sense they are being 'gutted' to make the most of an unexampled opportunity; so that when this orgy of production is over there will come the day of reckoning. Much cream will have been gathered and much blue milk will remain. But the reduction in price will be less violent than in the case of zinc or lead, because of the industrial demand for re-constructive work in Europe, including the ship-building that must follow the general resumption of peaceful traffic overseas. The drop in copper will not hurt the mining of the metal so much as it will deflate the balloon of speculation that is now being blown so assiduously by the forced production of the mines and the cheerful optimism of the brokers. There lies a real danger, as great as that of peace. And what a pitiable thing it is that Peace should be regarded as a menace to the welfare of any of us. Let us look forward to the day when our prosperity will not be built on the misery of others and the degradation of the human ideal.

The Mining Law

We note that the revision of the mining law is one of the many subjects to be discussed before the American Mining Congress at Chicago next week. On another page we publish part of a careful article on the mining regulations of various countries by Mr. William E. Colby, a distinguished Californian lawyer deeply versed in the complexities of the subject. It is a subject that will continue to vex us until either the present law is changed radically or we agree to let it alone for fear of worse. So far the attempts to introduce remedial legislation before Congress have met with disapproval even from those that insist on the necessity for sundry changes. For instance, the chairman at a recent meeting of the New York section of the Mining and Metallurgical Society of America, a technical organization that, despite its pretentiousness, has done real service to the mining public by a propaganda for the revision of the law, was constrained to say that Mr. Foster's bill "makes the situation, if possible, worse than under the present laws, and is not worth discussing." So bad are considered the various bills now before Congress for amending the mining law that Mr. W. R. Ingalls, aided by other members of the Society mentioned, has drafted a number of provisions meant to express the purpose

and desire of a group of mining engineers that has worked hard for several years to bring about some sort of reform. It is important to note that the idea of legislating for the appointment of a commission to revise the whole mining code has been abandoned by these gentlemen, who, after many consultations, have concluded that while one or two radical alterations are required it is best to change the existing regulations as little as possible, in order to retain the language of a law that has been tested and interpreted in a multitude of court decisions. This, it will be noted, is also the view urged by Mr. Falcon Joslin, an Alaskan engineer for whom we have much respect, in a letter published on another page, although he goes farther and opposes any tinkering whatever with the regulations now in force. Such of our readers as have taken the trouble to read the various articles on the subject and to attend conventions or other meetings at which the mining law has been discussed will realize that while there is a preponderance of opinion in favor of making changes, more particularly the abrogation of the extra-lateral right, nevertheless when it comes to devising a new law the enthusiasm of reform is dissipated in a dust-storm of inchoate ideas and half-baked proposals. For example, the protracted discussion before the New York section of the Mining and Metallurgical Society as printed in its bulletins gives a fair measure of the divergence of opinion even among a group of men having much in common, but if the suggestions made by these engineers were to be presented to a similar group of prospectors and small operators, people vitally affected by the law, the New York proposals would be met with howls of disapproval. For instance, the substitution of a cash payment in lieu of the \$100 worth of assessment work or the permission to locate claims without restriction of number or the locating of them along north-south lines would evoke lively objection; so would the idea of making it a misdemeanor for anybody to re-locate a claim. Behind these simpler, but important, matters there looms a number of bigger problems: the classification of the public lands into mineral and non-mineral, the right to mine on private land, the distinction between surface rights and mining rights, and the existence of State laws conflicting with any Congressional legislation. If the killing of the extra-lateral right goes with the abolition of the demand for a discovery of ore, is the locator to be allowed only a possessory title without discovery or is he to be granted a title in fee before he proves the existence of ore within his claim? If the latter proviso is to become a part of the new law, then again the Western miner will be up in arms against a reform so prejudicial to the prospector or locator without much money. The problem bristles with trouble. Such a bill as Senator Smoot's, supported as it appears to be by many of the mining engineers, because it is simple and drastic, without any effort to revise the whole system of land laws, would make confusion worse confounded. Nor have we much confidence in the provisions for a new mineral land law as outlined by the gentlemen in New York because,

whether we engineers like it or not, the formulation of laws must be done, in the last resort, by lawyers; at least, the codification of the geologists and engineers must be revised severely by men specially trained in such work before we can phrase a bill that will stand the test of the courts. Moreover, applaud as we may the public spirit of our reformer friends and sympathize as we do with their earnest desire to clear the complexities arising from the existing law, we do not believe that the changes suggested by them, in consultation with the big operators and financiers directly engaged in mining, will escape the sharp criticism and probably stalwart opposition of the men at the other end of the mining business, namely, the prospector, the day's pay miner, and the local operator, all of whom look for protection against the power of great wealth. If any change is to be made in the mining law it will have to be in a spirit similar to that prompting and underlying the first codifications of 1866 and 1872. Most engineers are accustomed to looking upon the existing law, associated with the name of Senator Stewart of Nevada, as the work of a few unscientific men, if not the production of a group of provincial lawyers. On the contrary, it embodies the experience of the mining communities in the West, primarily in California, and was based on the earlier mining traditions of Derbyshire and Cornwall, of the Hartz and Joachimsthal. It was a sublimate of human experience first in Europe and then in the new mining districts of Western America. The language of the existing law contains the words and the phrases taken from the miners' rules and regulations as adopted in scores of localities and modified during the period when the mining industry was in its vigorous infancy. The law has proved incomplete and inadequate because the wonderful variety of form assumed by ore deposits was not foreseen forty years ago, but it has been subjected to the hot fire of litigation so often and for so long that much of its refractory elements have been removed and it is today a workable body of regulations that is so well understood and so well supplemented by the decisions of the courts that the average man knows what to do in order to protect himself in his work of exploiting mineral. It appears to us therefore that the only alternative to the retention of the existing law is a total revision of the land laws of the United States. That is a task involving years of investigation by a commission of men specially qualified in the knowledge of the law and of mining. Any radical changes made now without exhaustive enquiry will entail hardship and confusion for a time, and we doubt if they are worth the price, believing that nothing short of fundamental revision will be satisfactory in the long run. We hope that our friends in New York will revert to their former idea of urging the appointment of a commission of five members, to include at least one lawyer and one representative of the Department of the Interior, besides others having experience in mining and in the acquisition of mineral lands, such a commission to be selected and appointed by the President of the United States.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

A Traveler's Library

The Editor:

Sir—If the engineer is 'traveling' on a fee with instructions to report the prospects for exploiting a mining property profitably, I would say that his sole library should consist of about 17 blank note-books and a gross of lead pencils. On the other hand, if he has inveigled someone into paying him money to take a post-graduate course in economic geology, then why stop at the index to the Transactions of the American Institute of Mining Engineers? Why not load the whole series on a pack-mule, and then utilize Dana, Lindgren, Spurr, Stretch, Pirsson, Kemp, Miller, Gunther, Kraus & Hunt, and a few others, to balance the load.

Books are media for conserving and distributing knowledge. They constitute the basis of education and are a 'loose-leaf' system for mental refreshment. But, after all, knowledge is based upon the principles postulated by Locke, to wit, perception and reflection. If an engineer has had the 'nerve' to pocket a fat fee to report upon a set of conditions coming within his supposed sphere, and relies on tabloid doses from his favorite author for inspiration in writing his 'report,' then he has missed his vocation. He should specialize as a parson or preacher, for example, for I have been informed that passable sermons can be purchased 'ready-made' to cover any conceivable topic.

Brother Spurr is good, for example. He is so good that I bought several copies to present to my attorneys, so that they could get the rudiments of physical and economic geology into their heads instead of taking their ideas on the installment plan and 'second-hand' from myself. This procedure saved me much trouble and at the same time insured to them a clarified instead of a muddled transmission of ideas. Furthermore, every engineer should have the standard works at hand for his 'brain-food,' because the whole of life's experience is but a tuition process. Any book can do no more than enable the student to think; and when Mr. Engineer goes into the field for a patron he has no time for anything else but to observe, correlate, estimate, and deduce, that is, to observe and think. The only book which might help him at that time has not yet been written; in fact the title has not been chosen, but it deals with 'How to Make Notes.' Hence the note-book and the pencil suggestion in my opening paragraph.

Knowledge is a synthesis, and its rightful application is an art. Its various elements cannot be aligned by manipulation of a slide-rule, neither can the processes

of wisdom be resolved into a system of tables. They are not transmissible or hereditary. Ability, or capacity, consists in being able to apply this psychological synthesis to new conditions and to formulate explanations for fresh phenomena. And seeing that all of our standard textbooks have spent their value when they have enabled us to think along some particular line, they are as much out of place to an engineer in the field as a 'eribbed' sermon would be to an evangelist. Of course this does not apply to a collation of formulæ, because the place for formulæ is between covers, as I hold to the theory that the only things with which to burden the memory are the multiplication table and "Thirty days has September," etc. I am particularly dogmatic upon this last point, as my own faculty in this respect is atrociously defective.

If an engineer goes into the field with any particular author or book fresh upon his mind, he is disqualified from rightly cognizing and estimating conditions, because he is likely to be looking for a condition to fit a theory instead of being technically receptive.

JOSEPH RALPH.

Salt Lake City, October 26.

On Ore Deposits

The Editor:

Sir—To generalize on the theories of ore deposition will no doubt advance our knowledge of the science and lead to valuable economic results. However, it is also productive of much harm. Indulgence in glittering generalities is too often a habit of the charlatan who wishes to impress the layman with his general and inexhaustible fund of knowledge. There is a peculiar fascination to people at a distance in phrases such as the following: "The prospect is situated in the great schist belt of Arizona which extends from Jerome to Ray and in which are found some of the greatest producing copper mines of the world." Such statements are not by any means uncommon especially in these boom times, and the circulation of them hurts the mining profession.

It would seem as though all that was necessary for one to assume the responsibility of advising the expenditure of money on mining projects is to have a natural facility for assimilating scientific expressions and the cultivation of this faculty by scattered reading of geological literature.

The cart-before-the-horse method in any branch of science does not promote progress. If we could have a

general house-cleaning in mining phraseology and get rid of some expressions like: "One man can see as far as another in the ground;" "No man can see beyond the end of his pick;" "A man is no good until he has had *n*-years of experience;" "Yellow-legged experts," etc., there would be a real chance for placing the mining profession on a dignified basis. Any number of academic degrees will not put an engineer beyond the reach of criticism but a proper mental attitude and feeling of respect among the men in the different branches of mining will do a great deal for the profession.

It appears that we are drifting away from the main argument. Your attention was called to glittering generalities as applied to geological theories. This also might be called the cart-before-the-horse method, which requires no laborious study of surface geology and underground conditions. All that is necessary is to allow the mind to "summon up the remembrance of things past" and build up a beautiful theory (with the aid of U. S. G. S. reports), then with a few alterations here and there (after a trip to the prospect) fit the theory to the ground. It makes excellent reading and if placed in the hands of the right people is sure to gain financial support.

To generalize in any science is to employ legitimate and correct methods for advancing that particular science. Also it is certainly proper to use a goodly supply of imagination. As Professor Daly says, "Geology is an exact science in the sense that a countless number of its observations are quantitative, with limits of error so small as to permit absolutely rigorous deductions." And again, "What Geology needs today is a frank recognition that imaginative thought is not dangerous to science but is the life blood of science." Obviously we must first stand on the solid ground of facts in so far as they can be observed and then build our theories from these facts. In addition to this the mining geologist must continually adjust his theories to harmonize with economic conditions.

It is indeed a pleasure to read articles such as Probert's 'Surficial Indications of Copper,' appearing recently in the pages of your paper. This kind of generalization is bound to advance the science of mining geology. Considering the amount of high-class scientific literature available it is regrettable that more of this work is not done. Consider Arizona as an illustration. Almost every mining district is described by a competent person, still it is extremely difficult to correlate the mass of data. Some of the publications are out of print or else are difficult to obtain and only a few libraries contain a complete list. Therefore, only a few men have the time and means to dig up this information and put it in compact form. Two of the most useful books we have are Lindgren's 'Mineral Deposits' and Wood's 'Copper Mines of the World,' but these books cover too wide a field to be entirely satisfactory.

It is interesting to speculate on the value of certain

general deductions that would naturally arise from such a correlation of material, for instance, in Arizona. It could probably be shown that there are well defined and definite mineralogical provinces each one of which has characteristics peculiar to itself and related to rock associations of definite geological age and kind. It is evident that a study of any one mine in each mineralogical province would give a basis upon which to determine the relative value of a given prospect. This would be a scientific basis upon which to generalize, besides being a valuable contribution to our general knowledge of mineral deposits.

It is not safe to generalize on the similarity of types. For example, the Paleozoic sediments are represented in widely separated areas in Arizona, but in almost each locality there are fundamental differences in structure and rock association. Therefore, the fact that a copper deposit occurs in Devonian and Carboniferous limestone near to, or associated with, acid intrusives is of no value as a general statement in spite of the fact that it is so often used as a favorable feature in exploiting prospects. To illustrate: The Bisbee deposits occur in Paleozoic limestone cut by intrusions of granitic porphyry. The copper deposits occur in the limestone and appear as irregular or rudely tabular masses, sometimes following the stratification. They are almost entirely oxidized, even down to depths of 1400 ft. below the surface. A large proportion of the total copper produced comes from the enriched chalcocite ores. Another prominent feature of these deposits is the close relation to structural conditions, such as the northwest-southeast Dividend fault, a small stock of granite-porphry intruded on the line of the fault, an open synclinal structure in the down-faulted Paleozoic beds, which is such that they dip in part toward the porphyry stock and in conjunction with the fault-plane form a trough pitching southeast. These deposits are classed as contact-metamorphic replacements in limestone. It is well known that this type of deposit occurs in a number of localities in Arizona. However, it is apparent that as a guide to prospecting or in fact as a basis for speculating on a particular district, even though there is evidence of mineralization in limestone in the vicinity of acid intrusions, the analogy is of little value. It is only by carrying the comparison down to minute details that we can make any really scientific deductions.

At Duenesne, also in Arizona, the ore occurs as a replacement in limestone mainly in or near the metamorphic zone along the limestone and quartz-monzonite contact. However, in contrast to Bisbee: (1) There is very little oxidation. (2) The ore as mined consists almost entirely of primary complex sulphides. (3) Thus far the profitable ore has not been found to extend to any great depth. The ore on the 500-ft. level of the Bonanza mine being low grade and the bodies irregular and small. (4) The metallization is not related to any strong or persistent faulting. There is however, a marked jointing and fissuring, which possibly has a direct bearing on the ore occurrence.

At Twin Buttes, south of Tucson, large bodies of primary ore occur below a garnetized bed containing but little copper. The ore consists of actinolite, magnetite, pyrite, and chalcopyrite. It is a replacement deposit in Paleozoic limestone at or near the contact of granite-porphry.

It will be observed that in the three localities cited, there are copper deposits occurring in Paleozoic limestone associated with acid intrusions, but in each case there are fundamental differences that must prevent any generalization of practical value. However, each district should be considered as a distinct mineralogical province and the boundaries for each district definitely ascertained in so far as it is possible from geological studies. When this has been done any group of people wishing to spend money on a prospect in any one of these districts would have scientific data of inestimable value.

This line of study applied to the State as a whole would permit of a number of valuable deductions, which would doubtless show similarities in certain localities. With such information it would be logical and scientific to form generalizations that would help in prospecting a new or partly developed property. It is surprising that Arizona has not a competent State Geologist to carry on this work, supplementing the special studies of individual mining districts by the U. S. Geological Survey.

FRED. B. ELY.

Superior, Arizona, October 28.

Arizona Bureau of Mines

The Editor:

Sir—I note on your first editorial page a very complete 'bawling out' for the Arizona State Bureau of Mines, and would suggest that your reader of press-letters read them a little more carefully. On the press-letter to which you refer, you quote us, and we quoted the *Mohave Daily Miner*. If you will notice where the quotation marks stop, you will note that only the last paragraph of the press-letter came from the Arizona State Bureau of Mines.

You will also note in the last paragraph, the only one which we wrote, that we have issued a booklet on the subject of the selling of copper, which booklet takes precisely the opposite view from that of the *Mohave Daily Miner*. I am sending you a copy of the booklet.

Probably one of the most important parts of our work is to secure co-operation and good feeling between the large and small operators in the State, and between the laboring man and the mine operators, and your editorial, which will be read by many of the operators and misinterpreted by them as you misinterpreted us, will do us much harm. We quoted the *Daily Miner* in order to get the people of the State to send for our bulletin, which goes into much more detail than a press-letter could. I wish to assure you that we do not in any way agree with the *Daily Miner*.

I am sending you an additional copy of the press let-

ter, and a copy of our Bulletin No. 36. I sincerely hope that you will make an effort to set us right.

CHARLES F. WILLIS,

Tucson, October 30.

Director.

[The press-letter came under the heading of 'Arizona State Bureau of Mines.' In this circular the quotation marks were used confusingly, being attached, within the quotation, to the word "independent" at the beginning of the second paragraph. The press-letter contained 38 lines from the *Mohave Daily Miner* and only 7 of the Director's own comment, in the course of which he expressed no criticism or disagreement with the long quotation preceding. We inferred, as any other careful reader of the press-letter would have done, that the Director of the Bureau endorsed the Mohave paper; if he did not, he should have said so; to quote another man at length without criticism is usually deemed a mark of approval.—EDITOR.]

Hardinge Mill at Inspiration

We have received the following telegram from Mr. H. W. Hardinge:

On page 636 your report regarding trial of Hardinge ball-mill at Inspiration reverses the statement made and should read the Hardinge mill did not receive a trial as a ball-mill. The report as published by you is an injustice to the Inspiration management the metallurgical fraternity and my company and places an authenticated misstatement in the hands of our competitors. The only competitive Hardinge ball-mills for the Inspiration company are now en route for Miami. The circumstances justify your correcting the mistake far as possible.

This refers to a statement made by Mr. David Cole, in a discussion on flotation in the course of which he dismissed the experiments made with various grinding machines. He states that only the Hardinge pebble-mill was tested and the inference is clear that the Hardinge ball-mill did *not* undergo trial at the time to which he refers, although we understand that since then the work done in the Miami mill has indicated that the Hardinge ball-mill is most effective, hence the sending of similar machines now to the Inspiration. On comparing Mr. Cole's final statement with what he had previously said, it is clear that a typographical error was made in the stenographic record of his remarks and that this error was inadvertently repeated by us. The statement should read: "Contrary to what I think is the popular impression, the conical type of ball-mill did *not* receive a trial at the Inspiration." In the same report of the Institute meeting, Dr. Gahl's reference to Mr. Laist's remarks should have read—so he informs us: "I believe fully everything that Mr. Laist says, except his compliments," *not* "conclusions." These gentlemen were on the most friendly terms, and not sparring, as the report might suggest. We obtained a revised version of his remarks from Dr. Gahl, but this detail was not corrected.

AN EIGHT-HOUR LAW for all employees has been passed in Ecuador, South America.

Revision of the Mining Law

By courtesy of Mr. Falcon Joslin we are enabled to publish a copy of his letter to the Chairman of the Committee on Mines.

Fairbanks, October 9, 1916.

Hon. M. D. Foster, Chairman Committee on Mines,
House Representatives, Washington, D. C.

Dear Sir: I have your circular letter of March 25 enclosing copy of H. R. 12275 relating to the revision of the metal-mining laws. I note that you invite criticism.

I am very firmly against any revision of the mining laws. I know there are many excellent men who advocate a revision and some of them are my friends, but I cannot agree with them. I think they are mistaken.

The existing law is the growth of years. It began with a skeleton law passed in 1866. It was extensively amended in 1872. In the forty years and more since then it has been interpreted by the courts in thousands of decisions and amended many times by Congress and by the local legislatures. Defects revealed by time or by the decisions have been dealt with as they appeared. In this respect the growth of the mining law has not been different from the growth of our constitution, our banking laws, or indeed any of our laws. All laws are the result of such growth. They are never made perfect and complete. Perfect mining laws are only an ideal which can never be attained. Many of those who now so eagerly advocate revision are thinking of perfection and forget the difficulties of its attainment.

Our mining law has some defects but not nearly as many as some would claim. It is a liberal law and one of the best in the world.

It is familiar to the prospectors and mining people and nearly all its provisions have had judicial interpretation. It is therefore definite and certain; if subjected to any changes, they will have to go through a long process of litigation before it will be as definite as the law now is. I say "any change," for practically every word and phrase must be tested by lawsuits sooner or later. It will take forty years of litigation to produce the certainty under the new revision that we have now. This would be so even if the revision were drawn by experts and passed as drawn. But our law-making machinery is more imperfect than the law. Congress is sure to turn out a botched up measure at best as full of defects as the present law. A Commission of experts might prepare an excellent Bill, but I venture to say its authors would not recognize it by the time it got through the first committee. By the time it left the Conference Committee it would be a conglomerate of farm-land law, conservation, labor-unionism, politics, and demagoguery that would drive the mining population to despair. Then would follow the long period of litigation and amendment. In my humble judgment we had better bear the ills we have.

In Alaska we have had some sad experience with revisions. There was a good coal land law, but the restless uplifters thought we could get a much better one. The

people in Alaska did not request it. They proposed to force it on us whether we liked it or not. And they did. The result is that our old law is repealed and we have an abortion of a coal-land leasing law wholly unworkable. We need coal up here. It is a cold country, but we can't get it, though we have been trying for twenty years.

The same thing with reference to the oil law. The placer law was not exactly designed for the development of the oilfields but it worked. I think it worked well. But up here they propose to revise it. In order to make sure it should be revised, they abrogated the existing law without substituting any other. So we have no oil-land law in Alaska at all. The revisers are busy and have been for six or seven years revising the oil laws; during all this time we have had no oil law at all. When their revised oil law is passed, if it ever is, it will probably be as unworkable as the coal law. They say it is progressive legislation. We think it is medieval, for it proposes to return to the feudal system of the dark ages; The Government, the landlord, and the citizens as tenants. We have had too much experience of revision to favor any more of it. With the prevailing sentiment in favor of conservation and restriction any new law would probably be far less liberal than the existing law. The draft you send proves this.

It contains restriction after restriction. It even threatens the poor devil of a prospector with criminal prosecution if he locates a claim without pure intentions. See Sec. 2346j. The number of claims a man may locate or even hold is limited to five quartz claims or one placer claim. The present law permits a man to locate or hold as many claims as he wants as long as he does the amount of work on each required by law. This is sensible and right. There might be more labor required to hold a claim, but there is no sense whatever in otherwise limiting the number one may locate or hold. I will not attempt to discuss other details of the Bill. I am against the whole project of a general revision. There is one feature of the Bill however which I favor. That is the provision for the appeal from the decision of the Land Office to the Courts in matters arising between the Government and the citizen.

The Land Department has committed some of the most highhanded and tyrannous doings in the administration of our coal and oil lands. The acts were oppressive and illegal, but by the present law a citizen has no redress even from the most shameful and flagrant conduct of the executive departments. If there had been the right of appeal from the decision of the executive departments to the courts our coal lands would not have been tied up for twenty years as they have been. In this amazing revision of the coal-land law for Alaska it is expressly and cunningly provided that a citizen wronged by the decisions of the Land Department shall not have the right of appeal to the courts. The revisers were afraid to have their doings reviewed by the courts and we American citizens must submit to that outrage. I certainly would favor these sections if they could be passed as a separate Act.

FALCON JOSLIN.



THE STEAMER 'AMUR' LOADING CONCENTRATE AT THE BRITANNIA WHARF.

The Britannia Mine and Mill

By T. A. Richard

During August I availed myself of an opportunity to visit the biggest copper mine in the British empire: the Britannia, on Howe sound, near Vancouver, British Columbia.

This is not a fresh discovery, nor is it a new enterprise. Like many other successful undertakings it was built on the stepping-stones of earlier failures. The first finding of copper in the district was reported in 1888, but no work was done until ten years later when Oliver Furry stumbled upon the same outcrop, a bluff of copper-bearing schist on the Jane claim, which he located. Several other claims were staked and a number of samples, averaging 7% copper, were taken.* Furry interested F. Turner, of Vancouver, and Leo Boscowitz, of Victoria, in the prospect. A trail was made and a camp was established; an adit also was started and driven for 150 ft., but, failing to cut ore, it was discontinued. Work was stopped. In February 1900, nearly two years later, Joseph Adams inspected the prospect and reported enthusiastically to H. C. Walters. The latter had just made some money out of a deal involving the Snowshoe mine, near Libby, Montana, and came at once to Vancouver, going thence to the Britannia, where he joined Adams in making a further investigation. The result was the organization of the Britannia Syndicate, which purchased seven-tenths of the Turner and Boscowitz hold-

ings for \$35,000. H. L. Van Wyck became superintendent. Another large outcrop was discovered on the Fairview claim and some development work was done.

The syndicate put the property on the market. In 1901 an examination was made by W. Yolen Williams, consulting engineer to the Granby Consolidated, but no business resulted. Walters went to London and aroused the interest of a capitalist named Valentine, who took a bond on the property for \$750,000 and made two payments of \$5000 per month before he had the mine examined by J. D. Kendall, who reported favorably. Then Valentine died and his executors relinquished the bond. Mr. Kendall's report, dated April 11, 1901, speaks of the 'ore-zone' as "over 100 ft. wide in one part and more than 2000 ft. in length." He estimated the ore 'in sight'—a term now taboo—at 850,000 tons assaying 0.083 oz. in gold and 0.19 oz. silver per ton, with 2.16% copper. He suggested the use of the Elmore bulk-oil process, believing that this would save 11.6% more than ordinary concentration by water. He estimated the cost of mining at 95 cents and that of milling at 50 cents per ton. Later knowledge indicates that Mr. Kendall's estimate of the average contents of the ore was correct; his forecast of cost is confirmed; and his suggestion to use the flotation process has been put into effect, although at the date of his report the radical changes to be made in Elmore's process were too far in the future to be anticipated by him, or anybody else. Mr. Kendall may well be proud of the report he made on the Britannia mine 15 years ago. That the report failed to stimu-

*For data concerning the history of the mine I am indebted largely to 'The Copper Handbook,' by the late Horace J. Stevens, and to an excellent article by E. A. Haggren in the *Mining, Engineering and Electrical Record* of August 1915.

late the exploitation of the deposit was due to the almanac: in 1901 the economic value of 2% copper ore was not understood.

Another start was made at the end of 1901, when George H. Robinson, an engineer of high rank, associated with important mining operations in Montana and Utah, bought the controlling interest in the Britannia Syndicate, on a report by James W. Neill, at a price of \$400,000. Evidently the syndicate made a reasonable profit. Later Robinson bought the three-tenths held by Turner and Boscowitz for \$53,000. He organized a new company called the Britannia Copper Syndicate, with the late Edgar E. Dewdney as president and himself as managing director. Another director was H. C. Bellinger. The capitalization was \$937,500 and the new stock was underwritten by Henry Stern, who had the financial aid of Grant B. Schley, of the firm of Moore & Schley, in the flotation of the issue.

Robinson started to develop and equip the mine systematically. An aerial tramway was erected, a concentrating mill was built, and new adits were started. The ore and concentrate were shipped to a smelter at Crofton, on the opposite coast of Vancouver island, 60 miles west. This plant included two blast-furnaces and one converter-stand, producing blister copper that was sent to Chrome, New Jersey, for electrolytic refining. A briquetting plant was used to prepare the copper concentrate for blast-furnace treatment. This smelter had been operated by the Southwestern Smelting & Refining Co., a local enterprise operating a copper mine on Mt. Sicker. In 1905 the Britannia Smelting Co., with a capital of \$625,000, acquired this metallurgical plant together with the Mt. Andrew mine on Prince of Wales island. But the Crofton smelter was not a success; it was closed down in 1910, and has been dismantled, the useful portions of the equipment being transferred to the Britannia mine. When Robinson died, in 1905, he was succeeded, as manager, by M. T. Adams.

In 1908 the Britannia Mining & Smelting Co. was organized with a capital of \$2,500,000, absorbing both the Copper Syndicate and the Smelting Company of the same name. At this time Mr. Schley came into personal control of the enterprise and R. H. Leach was appointed manager with H. C. Bellinger as consulting engineer. But Horace J. Stevens said truly and gently in 1909, "The Britannia to date has proven somewhat disappointing." This qualified statement was correct at that time; it was not until nearly five years later that the mine, then 14 years of age, began to give signs of real vitality. In 1912 Mr. Schley placed J. W. D. Moodie in charge and under his management the enterprise has been developed to fruition. The method of milling has been changed, a new mill has been built, also an incline tramway capable of transporting a large tonnage of ore, vigorous exploration has uncovered ever increasing ore-reserves, and the property has been enlarged from 1500 acres to 20,000 acres. However, the resources of a mine are not measured in acreage; the comparison simply serves to indicate that exploratory work has proved the extension of the ore-bearing belt for miles and furnished

the basis for large-scale operations of a most successful and systematic kind, under the direction of two men, a sagacious financier and a capable engineer.

In an earlier article I have described the short voyage from Vancouver to Britannia Beach, as the settlement on the shore of Howe sound is called. The distance by water is 30 miles; overland from North Vancouver it is about 22 miles; eventually the coast railway, now terminating at Horse-Shoe bay, just around the corner into Howe sound, will be extended to Britannia Beach, but the present method of transport by water is convenient and cheap.

On landing the visitor finds a clean and well organized settlement. The population on the beach, near the mill, is 1000; on the hill, near the mine, it is 800 more. The pay-roll shows 1225 employees, of 20 different nationalities. The company maintains a four-story, 60 by 132 ft., department store in which an abundant variety of supplies is displayed. Construction work is still in progress and will continue for many years, as the mine and mill grow in size. Three mill-buildings are to be seen; first, the old zinc-concentrating plant, built in 1908, which was never operated; second, the concentrator, remodeled in 1912, enlarging its capacity from 500 tons to 850 tons daily, using both water and oil concentration; third, the new mill of 2500-ton capacity, begun in 1913, employing the old and new processes in sequel.

Let us visit this new mill, which is built on a side-hill site, in six floors, having a total height of 191 ft., or 216 ft. to the top of the receiving-bins. Of the four units into which this plant is divided, three were in gear on August 27, treating 1700 tons daily. The mill-crew numbers 83 men, of whom 25 are Japanese. The building is airy, light, and spacious. The floor-space is ample, facilitating alterations. The walls are white-washed. The frame and housing are made of wood, on concrete foundations resting in solid rock. Each section of the mill has two angle-bottom ore-bins each of 500 tons capacity, so that the two sections already built have a storage capacity of 2000 tons. In addition, a stock-pile is maintained on the side-hill giving 25,000 tons more in reserve. This is fed by the aerial tramway, built originally for the old mill, and passing to one side of the new mill, so as to permit the accumulation of ore on a rocky platform cut into the ground just above the bins. The stock-pile is drawn onto a belt-conveyor that delivers into the mill bins. In front of these passes a chain-bucket sampler. Three 12 by 24-in. plunger feeders deliver the ore (broken at the mine to 3½-in. ring) to three 4 by 8 ft. trommels having 1½-in. round holes. My description will now concern itself with one unit of the mill, the other being an exact duplicate. The undersize from the trommel goes direct to the coarse rolls, the oversize to two picking-belts.

Here the ore can be examined. It consists of copper pyrite in chloritic schist. The ore picked from the belt

3A composite analysis of the mill-feed in September showed 2.74% copper, 7.95% iron, 1.5% zinc, 6% sulphur, and 71.25% silica, besides a trace of gold and 25 cents worth of silver per ton.

contains from 10 to 18% copper and represents about one-tenth of the entire mill output, which averages 15 to 16% as shipped, ore and concentrate, to the smelter at Tacoma. The ore is of medium hardness and breaks readily, loosening the chalcopyrite; it is of simple type; with the chalcopyrite there is twice as much iron pyrite, besides a little zinc-blende and galena. Associated with these sulphides is quartz.† The proportion of picked ore varies in accordance with the smelter requirement of silicious material.

Two men work at each picking-belt; they remove the

after passing through the sampler, goes direct to the bins, where it is allowed to drain before being shipped. The middling from the tables goes to a 7 by 10-in. bucket-elevator for re-treatment by one of the tables. The tailing from these runs to a two-compartment dewatering tank, the overflow from which is delivered to the final slime-tanks. The sediment from the dewatering tank is used as part of the feed to the tube-mills.

The tailing from the jigs is fed to the 'fine' rolls; the middling goes in close circuit back to the jigs; while the concentrate is transferred to the shipment-bins.

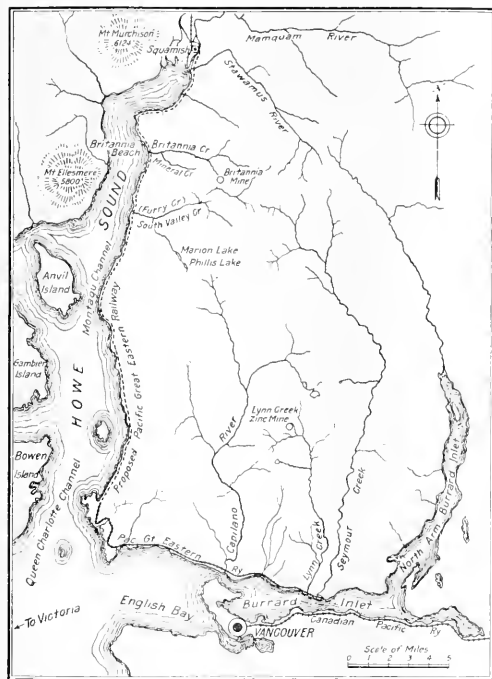
The oversize and undersize of the first set of trommels unite at the 'coarse' rolls.

The jig-tailing goes to the four 'fine' rolls, as already stated; these rolls are 36 by 15 in., style A, Allis-Chalmers, crushing from $\frac{1}{4}$ inch to 2 mm. and delivering to eight tube-mills or 'granulators,' each 7 by 12 ft. and direct-driven by a 100-hp. slip-ring motor. These tube-mills are given a retarded discharge by means of a back-worm. The lining is made of rail-sections (5 in. long) set on end in neat cement, with short pieces of worn-out drill-steel in the interstices. This affords excellent service; it is called the 'Britannia' lining and deserves to be well-known. The secret of the success of this lining is that the neat cement is placed on the smooth clean surface of the tube-mill, and in this cement are imbedded the ends of the rails, grouting them with more neat cement as the tube is turned gradually until a half-circuit has been made, by which time (three to five days) the cement has set so firmly that the rails do not fall out. The grinding-stones, selected from the picking-belts, as we have seen, are delivered through chutes in the bed-rock under the mill and taken by a belt-conveyor to a bin on the tube-mill floor, where they are fed into a bucket hung on a rail and pushed by hand. These grinding-stones, or 'pebbles,' are fed by hand into the discharge end of the tube. At the feed end there is a three-spout feeder. The discharge from the tube-mills goes to the boot of a 72-ft. elevator with 16-in. buckets that deliver to three hydraulic classifiers, the overflow from which passes to the flotation machines while the oversize is returned to the tube-mills.

The various products of the mill are divided thus:

	Proportion %	Copper content %
Picked ore	10	10 to 18
Jig concentrate	25	16 to 17
Table concentrate	25	14 to 15
Flotation concentrate	40	14 to 15

The flotation plant consists of two Minerals Separation machines of the blade-impeller type, each divided into 14 cells, operated by a 250-hp. Pelton wheel. In this mill the impeller or agitator makes 180 r.p.m.; in the old mill, 215 r.p.m. The oil is introduced as a continuous thin stream into the feed-launders. The quantity used is 42 gal. per 1000 tons of ore, a British gallon weighing 9 $\frac{1}{2}$ lb., so the consumption is equal to $\frac{2}{3}$ pound per ton of ore. The oil now being used is pine-oil, the variety known as No. 350 made by the Pensacola Tar & Turpentine Co. in Florida. Recent experiments with fir-oil, a



MAP SHOWING POSITION OF THE BRITANNIA MINE.

pieces of high-grade ore to one side and also select hard pieces of country-rock for use as grinders in the tube-mills. A chute for waste is available, but it is not in use now. The picking-belt delivers to three 10 by 20-in. Blake jaw-crushers, which reduce the ore to 2-in. size before passing it to two 16 by 48-in. extra-heavy spring-rolls. The product from these goes to three 15 by 40-in. Anaconda type of spring-rolls. The first set of rolls reduces from 2 to $\frac{1}{2}$ inch, and the next to $\frac{1}{4}$ -in. size. These deliver to five trommels, 3 by 6 ft., having $\frac{1}{4}$ -in. holes, the oversize passing to two 10-in. bucket-elevators that return this product to the second set of rolls, while the undersize from the trommels is delivered to five 3 by 6-ft. trommels with 1.5 mm. screen. The oversize from these is passed to two 14-in. bucket-elevators, which feed two Hancock jigs, while the undersize from the last trommels goes to five tables of the Overstrom type with plain riffles lengthwise. The concentrate from the tables,

product from the distillation of Douglas fir, by use of the Cottrell process, has been tried successfully. No acid is used. Out of the 14 cells, four are used for making a concentrate and the other ten for re-treating or cleaning. In the lower ten cells the froth is drab in color, dense in texture, and well pitted with the breaking bubbles. When discharging over the edge by impulsion of the scrapers it shows blotches of foam, the lighter tint of which is due to the silicious gangue. In the upper cells the froth is more uniform in texture, it shows dark greenish-gray where the scraper sends it over the edge. A revolving scraper moves the froth forward in the re-treatment or 'cleaning' cells. A trowel-scraper extends over the entire surface of the outer frothing-cell.

The aromatic smell of the pine-oil is strong in the mill, but this smell is not detectable when rubbing the concentrate between the fingers nor does the concentrate show any oily streak. The tailing discharge, on the beach, gives forth a strong smell of pine-oil, suggesting that some of it is dissolved by the water.

On the day of my visit the flotation record showed:

	Copper %
Feed	1.90
Concentrate	14.0
Tailing	0.12

The concentrate contained 26.8% iron and 20.8% silica. This concentrate goes directly to a drag-elevator that delivers it to the shipment-bins. The moisture in the concentrate is fully 20% and is reduced by draining to 8% before being loaded on board ship. The smelter at Tacoma draws the line at 10% moisture. Two 50 by 14-ft. Dorr thickeners are being erected to take the overflow from the slime-tanks, the sediment to be returned for treatment in the flotation machines, while the overflow empties into the tailing-launders.

Experience has shown that the poorer the feed the better the recovery, so that a point is reached where the flotation machine loses in relative efficiency; hence the picking-belts, the jigs, and tables. There is also the question of royalty, into which I shall not go, although local gossip is alive with interesting stories.

Between the shipment-bins there are tanks that receive the overflow from the concentrate, the sediment accumulated from this overflow going to the flotation machines, while the rest of the overflow passes to the Dorr thickeners.

By way of comment it may be suggested that the chloritic character of the schist serves to explain the ease with which the chalcopyrite is detached and concentrated. The only chemical or nostrum used is the oil. No acid is needed; it may be that the slight oxidation of the pyrite is accelerated by friction during the crushing of the ore sufficiently to produce enough sulphate to furnish acidity automatically. The proportion of iron to silica in the concentrate makes a self-fluxing mixture and suggests that the degree of concentration is determined, or might well be determined, by friendly consultation with the smelter management. The smelter allows a minimum payment of 25c. per ton on the gold

and \$20 per ounce on all above 0.03 oz. per ton. For silver 95% of the market price on the day of arrival at Tacoma is paid. The concentrate averages 0.0225 oz. gold, 1.65 oz. silver, and 15% copper. The recovery on August 28, as indicated, was 94%; it is said to average 95%, while the extraction over all, after smelting of the concentrate, is 93% of the copper in the ore as recovered from the mine. This is splendid work, of course. The cost of hydro-electric power is \$10 per hp.-year, allowing 10% for depreciation of plant. The cost of milling is 56 cents, but this it is expected to reduce to 30 cents when the plant is completed. The cost of transport to the smelter is 66c. per ton dry. For the removal of the mill-products, a tunnel has been driven through the rock beneath both mills. This is ingenious and convenient.

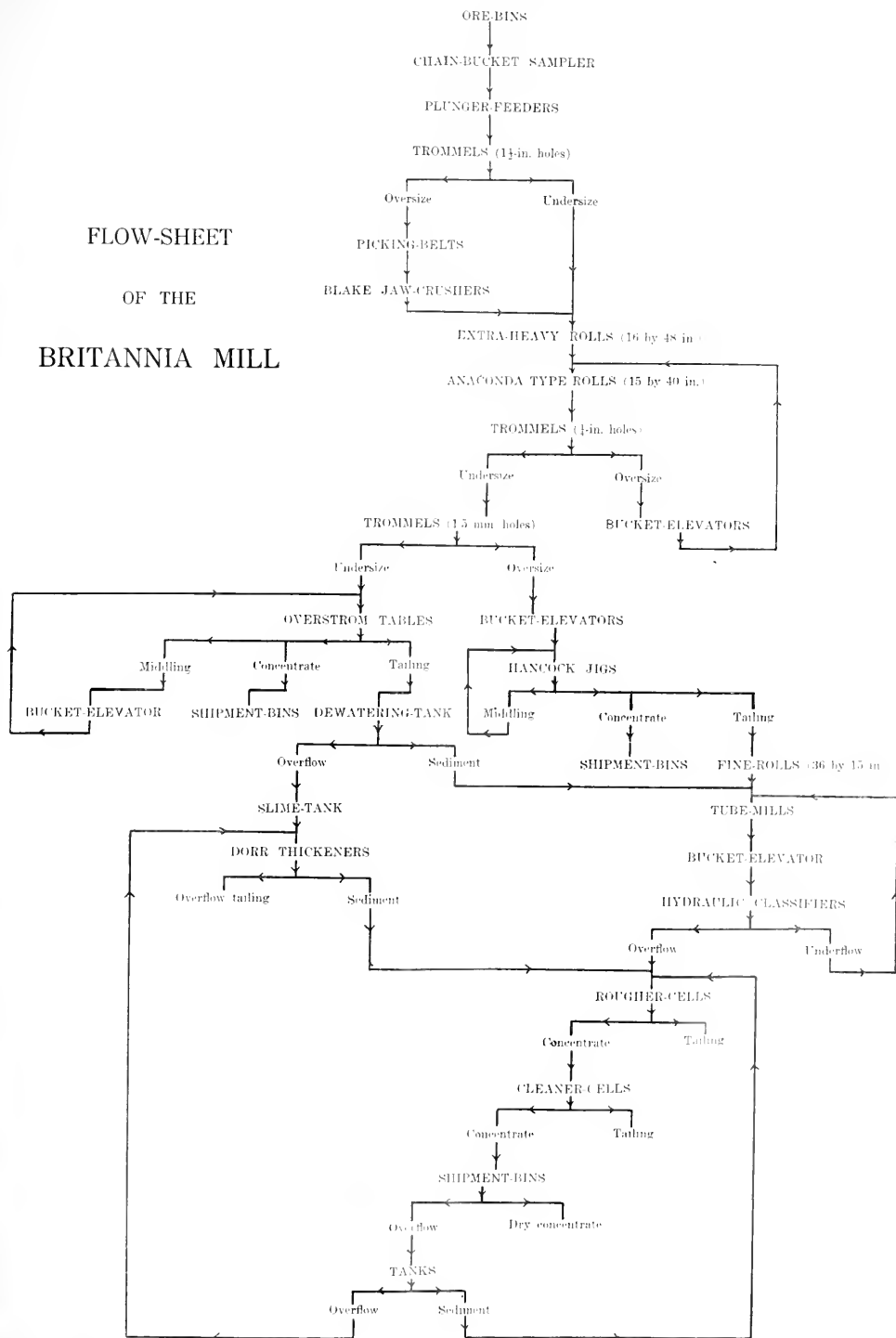
The magnetic zinc-concentrating mill, with its McDougall roaster, stands between the manager's house and the old vanner building. This plant was never started, having been recognized as useless, and is now being dismantled. One part, the old Jane workings, of the mine contained zinky ore with enough gold and silver to prompt the attempt to separate the zinc and precious metals from the copper.

On the day following my visit to the mill I was taken by C. P. Browning (Columbia, class of '13), the general superintendent, to the mine on the mountain, which rises to a height of 4300 ft. above the water.

While waiting for the car at the mill-terminal of the incline-tramway I had a look over the settlement outspread on the beach below; the little houses with their red or green roofs; the big department store and office-buildings, and beyond them the wharf projecting into the calm waters of the inlet, its rim marked by the white line of high water, where the rock is bared and bleached; the boats and their reflections; the successive headlands; the high cliffs and wooded hills culminating far away in the snowfields of Mt. Sir Roderick, named after one of the worthies of geology, Sir Roderick Murchison. Across the sound a paper-mill had the look of a chateau and recalled memories of the Dauphiné that were broken by the dumping of 20 tons of ore, the noise of which reverberates among the hills.

Sitting in front of an open-front skip, which weighed 13 tons when empty, we ascended the incline. The grade is undulating; it averages 30%, with a maximum of 33% and a minimum of 12%. The road-bed, 5500 ft. long, is 18 ft. wide and is laid with two standard-gauge (4 ft. 8½ in.) tracks of 56-lb. rail, passing through several cuts, as much as 55 ft. deep. The absence of trestles, except at the terminals, gives the tramway a solidity that is enhanced by the method of anchorage. The top of each rail is anchored to the tie by two ¾-in. slots cut in the bottom of the rail, to receive the spikes holding the rail to the ties. These are securely imbedded, thus enabling each length of rail to expand and contract independently of the track as a whole. To further this result, special attention was given to the tightening of the fish-plates and the spacing between rail-ends, with proper regard for the temperature at the time of laying. At intervals

FLOW-SHEET OF THE BRITANNIA MILL



of 1000 ft. firm anchorages were made in solid rock under the road-bed; to these were attached turn-buckles connected to the base of the four rails, so that, in the event of the track being pushed down-hill, the creep would be arrested by these extraordinarily strong anchorages. The wisdom of this precaution has been proved, no downward movement of the track having taken place.

From the car we could see the water-line descending the mountain. This consists of 7800 ft. of 36-inch wood-stave pipe reduced to 30 and 28 inches successively, then 3700 ft. of 28 and 26-in. steel pipe, delivering to two 20-in. pipes, 3150 ft. long, reducing to 18 inches. Thus the total length is 14,650 ft. The cost of flanges under a head of over 1000 ft. would be excessive if a single line of pipe were used with thread and couple; therefore the double pipe. The wooden stave is used up to a head of 500 feet.

The cable of the tramway is $1\frac{1}{2}$ inches of plough-steel. The skip has a false bottom of wood two inches thick enclosed in $\frac{5}{16}$ -inch steel plate. The wooden filler acts as a cushion. Each side of the skip consists of two steel plates. The loading-bins at the upper terminal have a capacity of 3000 tons. The engineer in charge of the lowering-engine is placed in an upper chamber above the concrete arch covering the machinery, so that while he cannot see the mechanism he has an uninterrupted view of the incline. The loading-bins of this tramway-terminal are fed by an electric train running on a track of 3-ft. gauge laid with 45-lb. rail and $3\frac{1}{2}$ miles long. The maximum gradient is 3% and the difference of elevation between the terminal points is 500 ft. A 15-ton electric locomotive pulls 4 cars, each of 20-ton capacity. These are U-shaped; the whole bottom is on end-rollers so that the car tips sideways. A tight bottom is necessary to prevent leakage of the fine, which is the richest portion of the ore.

The joint tramway and railroad terminal is level with Adit 27, so-called because it is 2700 ft. below the summit of the mountain. This will become eventually the base entry of the mine. Behind the mill is the entry of Adit 41, similarly 4100 ft. below datum. This adit will become the base exit for ore, it is only 1100 ft. long as yet, but it will be extended three miles to the ore-belt and at a mile from daylight it will connect by a raise, or shaft, with the upper adits, called 31, 27, and the present main entry, called The Tunnel, which is 1900 ft. above 41 and 2100 ft. above sea-level. The sizes of these new adits are

41	9 by 13 ft.
31	8 " 8 "
27	9 " 13 "

We went to Adit 27, a short distance south of the incline-terminal. This level was 900 ft. long and is expected to tap ore at a distance of 10,000 ft., but it will get under the old Daisy workings at a distance of only 2000 ft. from daylight. The cost of the work is \$13 per foot, the contractor paying for supplies and laying a temporary track. The ground breaks well, but is hard enough to stand without timbering. Two Ingersoll-Rand

drills, 43 $\frac{1}{2}$ B. with 3 $\frac{1}{2}$ -in. cylinder, are used on a 12-ft. bar, which is steadied by a right-angle bar against the face.

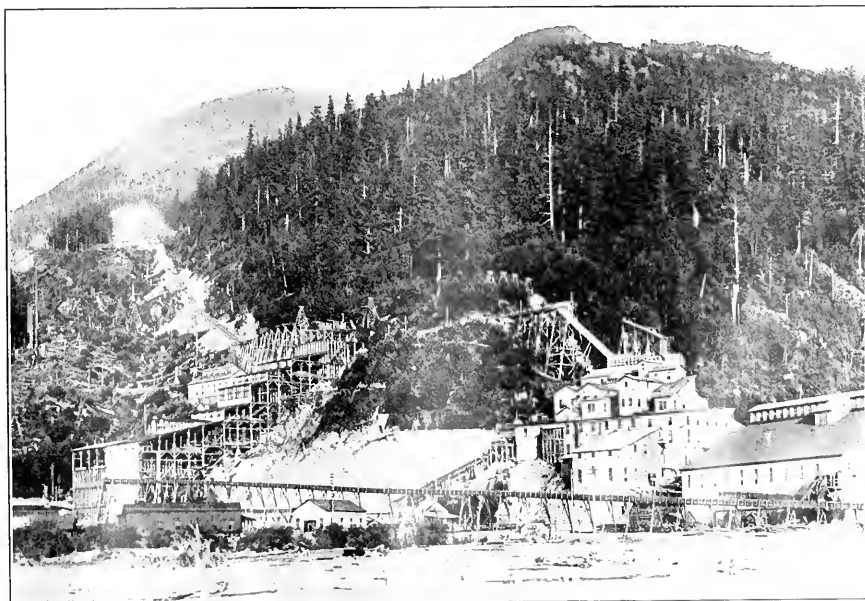
The electric train took us up the mountain, along two sharp curves and one switch-back, past the powder-magazine, to the Tunnel Camp, as the upper settlement is called. Here is to be seen some of the wreckage left from the big snow-slide that killed 55 persons, including some women and children, in March 1915. On this gruesome subject I shall not linger, remarking only that it distressed Mr. Schley and the management exceedingly, and that everything was done generously that could be done for the victims and their dependents. The settlement stands in a clearing made in a dense forest of young pine, overlooked by high peaks. The Tunnel, or present haulage-adit, is 2100 ft. above sea-level, 9 by 13 ft. in cross-section, and 4336 ft. long. Eventually it will be extended through the mountain, right across the fairview ore-belt, and will then become truly a 'tunnel.' Alongside the track I noted the 12-in. air-pipe and the high-tension transmission line, carrying 6600 volts. At 4100 ft. this adit connects with the main ore-chute, 8 by 12 ft., extending for 1272 ft. between levels. We watched the loading of four cars, of 20 tons each, in four minutes. Ordinary are-gates, 39 in. wide, are used. There are two gates, so that one can be in service when the other happens to be blocked. A vertical board levels the load in the car and prevents contact with the trolley-wire. The ore is broken by a gyratory crusher in a chamber 400 ft. above the adit and the chute is fed 800 ft. higher above the crusher, so that a storage capacity of 2000 tons of crushed ore is obtained, besides 4000 tons uncrushed ore between the 1800 and 1000-ft. levels. Above the top of this chute, on the 1000-ft. level, there is 4000 tons more ore stored in similar raises.

On the 1800-ft. level, 400 ft. above the haulage-adit, is the gyratory crusher, where the ore is by-passed from the main chute over a grizzly made of wedge-shaped manganese-steel bars $3\frac{1}{2}$ in. apart. The ore passing through the grizzly joins the crushed product and falls back into the chute.

Ascending on the cage of the interior shaft, 10 by 20 ft., we reached the 1600-ft. level, which is 600 ft. above the haulage-adit. This shaft was made by raising 1275 ft. from top to bottom, 75 ft. being required for head-room above the hoist. There I saw the ore being dumped into the chute and also had my first look at ore in place. This level will be connected with an adit advancing from Furry creek, which parallels Britannia creek in the next valley southward. On the 1200-ft. level I saw a cross-cut that was intersecting the Third vein, and then rising to the 1000-ft. level I saw the hoisting-engine and the top of the big chute. The seven side-dumping cars emptied themselves automatically as they passed the opening, the wheels on one side running over a dumping bar so as to tilt the car. These cars are modeled on the design originated at the Phoenix mines of the Granby Consolidated. Listening to the ore as it



BRITANNIA BEACH. THE LARGE BUILDING IS THE COMPANY'S DEPARTMENT STORE. ACROSS THE WATER IS SEEN THE OTHER SHORE OF HOWE SOUND.



THE BRITANNIA MILLS. THE NEW ONE, ON THE LEFT, IS SHOWN IN COURSE OF CONSTRUCTION.

fell down the chute there came the suggestion that the drop must shatter the ore to pieces so that half of it passes through the grizzly above the crusher.

From the top of the chute it is only 1300 ft. to daylight, so we made our exit and saw the old camp and more traces of the big snow-slide. At the portal is the outcrop called the Bluff, which has been photographed often to suggest the bigness of the lode-channel, here fully 300 ft. wide of 1.8% copper. On the west side of the ravine is a glory hole on the Jane claim and the entrance of an adit 1000 ft. long, all part of the work done originally under Robinson's direction. But none of this early development sufficed to expose the real dimensions of the ore-belt. It is not a single vein nor even a series of them but a big width of schist enriched by seams of chalcopryrite. As yet 11 veins have been labeled in a belt 800 ft. wide; the average stopping-width of each vein is put at 30 ft. and the maximum at 80 ft.; but such measurements are only suggestive, the actual width of ground to be stoped is yet to be determined by further operations. In length the separate orebodies have been proved for 1000 ft., and in depth for 1600 feet.

The chalcopryrite is confined mainly to fissured channels in a silicified sericitic schist, adjacent to a diorite-porphry. Near the ore the schist is spotted with chlorite. Any rock broken in the course of exploratory work is sent to the mill if it contains 1% copper. At the existing price (28c. of copper such material can be treated as 'ore.' The run-of-mine contains about 2½% copper. These facts I drew out of Mr. Browning as he and I, in the congenial company of W. A. Wylie, the mine superintendent, sat on some timbers and munched our sandwiches.

Questioning them regarding drills, I ascertained that the Waugh 11A is used for stoping; for driving and cross-cutting, the Dreadnaught, a valveless hammer-machine of the water-Leyner type; for block-holing and light sinking, the Rand jack hammer and the Denver clipper; for glory-holing, the Rand 43½ and Dreadnaughts equipped with handles. By discarding the shell the weight of the last is reduced from 115 to 90 lb. Four Leyner No. 5 drill-sharpeners are in use and three Sullivan sharpeners. The mine will be worked by shrinkage stoping and 'glory-holing,' or big open-cuts.

While smoking the pipe of peace I enjoyed an occasional glance at the steep sides of Britannia mountain, heavily timbered fortunately, otherwise snow-slides would be frequent, and across the ravine the fir forest at the foot of the red rampart of Goat Mtn., on which the Rocky Mountain goat, or *mauiama montana*, disports himself freely.

Re-entering the mine at the 1000 ft. level, we ascended in the skip to the 500 ft. level, where I saw the Denver Engineering 75 hp. electrically driven hoist. Mr. Wylie said that it had been in use four years and had never given any trouble. In a chamber, 18 by 36 ft., near by, I found a No. 5 Leyner drill sharpener and a Sullivan sharpener, with a repair equipment, including a 10 hp. motor, drill press, grinder, and pipe threading machine.

Thence we walked to the other portal of the level, truly a 'tunnel,' which is 1500 ft. long, to the Furry Creek side of the mountain. The southern portal, called the Barbara, gave us a new outlook. A thick forest of hemlock, yellow cedar, and larch veiled the view, but between the tall stems I caught glimpses of snowy peaks, dark mountains, and the misty abyss of a deep canyon from the bottom of which came the roar of a torrent, like a stamp mill. Eastward the sky-line showed a gap in the Seymour divide, on the far side of which is the watershed of Seymour creek, flowing to North Vancouver. To that sky-line, fully five miles distant, the copper-bearing territory is said to extend. Turning round and examining the rock of the portal I could see the fresh face of Fairview schist, streaked with pyrite and chalcopryrite, but not rich enough to be 'ore.' The 500-ft. tunnel is in ore for 1000 out of its 1500 ft.; it intersects all the 'veins' from the Second to the Tenth, but it is not at right-angles to the ore-belt, so that the real width of ore traversed is 800 ft. The cross-cuts run due magnetic north and south; the 'veins' run S 80° E and dip 70° south with general uniformity.

On the 500-ft. tunnel horse-traction is employed. It is planned to replace this method with a storage-battery locomotive, also on the 600, 850, 1000, 1200, and 1600-ft. levels; in fact, wherever the present electric railway does not serve as a means of transport. A 3-ton Westinghouse locomotive with 'exide' (litharge) cells will pull 6 cars of 2 tons each. In breaking 2000 tons of ore daily, 2000 bits are blunted and 1½ tons of powder is consumed.

In the mine a reserve of 700,000 tons of ore broken by shrinkage is maintained. As for the total reserves, the mine is too young and undeveloped for a precise estimate, but 17,000,000 tons is said to be reasonably assured already. The total cost of producing copper is 7.3 cents per pound.

Metals Through the Sault St. Marie Canals

During the six months ending with September the American and Canadian canals, between lakes Superior and Huron and Michigan, reported as follows:

	1916	1915
Vessels	18,845	14,907
Registered net tonnage	51,701,240	38,578,998
East-bound:		
Copper, tons	83,669	95,373
Iron ore, tons	47,370,350	33,761,752
Pig iron, tons	29,896	6,914
West-bound:		
Coal: Hard, tons	1,609,481	1,448,734
Soft, tons	11,039,178	8,106,063
Manufactured iron, tons	116,411	134,137
Iron ore, tons	28,927	.....
Salt, barrels	572,489	481,170
Total freight, including other materials	68,455,497	48,383,603

Of the totals, the American canal handled 55,229,198 tons in 1916 and 41,888,436 tons in 1915.

The Extra-Lateral Right—Shall it be Abolished?

By William E. Colby

There is no feature of the American mining law that has provoked more spirited discussion and against which a greater amount of criticism has been aimed than the extra-lateral right, or 'law of apex,' or dip right, as it is variously termed. It has become quite popular to present the arraignment of charges that can legitimately be made against the practical operation of this right and there is scarcely a meeting of importance connected with the mining industry where some one does not add to this volume of condemnation. In all this discussion, it is rare to find a word of commendation; not only are the advantages which flow from the exercise of this right ignored, but in the general demand for its abolition we find very little well considered thought given to the serious results of such action and few suggestions as to what steps should be taken to minimize the grave consequences that are bound to follow such a radical and far-reaching change in our mining law. We are too prone to assume that legislation is a panacea for all defects in existing laws and not enough attention is paid to the evils which inevitably flow from 'half-baked' remedial statutes. Judging from the published remarks of many who have criticized the extra-lateral right, the opinion seems to be quite prevalent that all that is necessary to be done to cure the ills that are inherent in the 'law of apex' is for Congress to pass a statute abolishing it.¹

COMPARATIVE TREATMENT. In a discussion of this character it is interesting to know whether other systems of mining law have similar features and what has been the result of their operation. It has been erroneously assumed by many that the extra-lateral right is a unique burden suffered by the United States alone. An examination of the laws of other countries shows that this is not a fact. Naturally we cannot expect to find in other countries an extra-lateral law identical in all respects with our own. It is the fundamental principle underlying this law that is vital,² namely, the right to mine on and pursue a vein in depth beneath surface ground that is not owned or controlled by the mine operator. In other words, the right to follow the vein in depth is independent of and is not measured by surface ownership, hence it is termed the right of extra-lateral pursuit. It is usually described as being opposed in principle to the common-law idea of ownership of land, where the owner of the surface is entitled to everything situated

vertically beneath. As Judge Lindley has pointed out in his treatise on the law of mines,³ the common law recognized the right of severance and frequently the surface-owner conveyed to another the right to mine a vein or mineral-bearing strata that penetrated or lay beneath his surface. However, the extra-lateral right as we ordinarily conceive of it has an element that did not exist in the common law. In the exercise of the extra-lateral right the vein may be pursued *indefinitely* in depth beneath the surface of adjoining owners who have nothing to say about the exercise of this right underneath their ground and are powerless to prevent it. The right has been created by statute or custom before their surface-ownership attached and the vein has been reserved and carved out of their estate. It is the statutory or customary origin of the right, giving it an indefinite sweep in depth and the fact that it is not at all dependent upon conveyance from private owners of overlying surface nor for its measurement upon the vertical boundaries of such surface-ownership that distinguishes the extra-lateral right from the common-law severance of minerals from the surface.

We have no definite information as to whether an extra-lateral right was exercised in ancient times. The existing record of these ancient mining laws is meagre and a great part of the mining was carried on as a sovereign venture so that the question of extra-lateral pursuit would seldom arise.⁴ It is only when there are adjoining private ownerships that a situation is created where the question becomes important.

Under the democratic control of Athens the silver-lead mines of Mt. Laurion were leased in small adjoining areas to individuals. One might expect to find the extra-lateral right a feature of the ancient Greek mining law were it not for the fact that these were flat-lying contact deposits occupying horizontal beds and hence unsuited to the exercise of any dip-right.⁵

SPAIN AND SPANISH AMERICA (PERU AND MEXICO). The fabulous wealth of the mines worked under Spanish rule, particularly in her possessions in the New World, stimulates our interest in her mining laws.

While we would naturally expect Spanish laws to reflect the influence of the civil law, we find little impress on her mining code from this source. In making an analytical study of the Spanish mining laws one is struck by the similarity of many of the provisions to those of the early Germanic mining codes, especially the right of

¹There are several bills to amend our mining laws pending before the present Congress. One of these would abolish the extra-lateral right without any provisions to relieve the serious consequences of such action. This discussion is prompted by this proposed revision.

²"The application of the term 'extra-lateral' to this right is of comparatively recent origin and the right existed long prior to this designation." 'Lindley on Mines,' 3d Ed. p. 568.

³'Lindley on Mines,' 2d Ed. p. 568.

⁴Those interested in the subject of ancient mining laws will find an excellent note at pp. 82-86 of Hoover's translation of Agricola, 'De Re Metallica.'

⁵See 'Hoover's Agricola,' p. 83, foot-note.

free mining, that is, the right of the individual to go upon crown lands or even lands belonging to others and upon making a discovery of mineral becoming entitled as a matter of right to the possession of a mining claim including the discovery. But the similarity is accounted for when we learn that in framing the mining ordinances of Spain "recourse was had to the laws of Germany."⁶

Article 5 of the Spanish mining ordinances of 1559, mentioned by Gamboa, as the "old ordinances," provides that,

"Whereas, by not designating the limit and space which the mines that shall thus be discovered are to have, there may result great confusion, differences and lawsuits; and the first discoverer may pretend that his mine and the right which by discovery may belong to him, cover and include the whole extent and continuation of the metallic vein, and that in the whole of such extent and continuation no person can interfere to prospect, search or work, from which may result great embarrassment and impediment to the discovery, and working and development of said mines,"

therefore, the article provides, the mine or *pertenencia* to which a discoverer is entitled shall have definite surface boundaries, namely, 100 *varas* long and 50 *varas* wide.⁷

This provision would seem to have eliminated the exercise of any extra-lateral right and this is further borne out by Article 29, which provided that if mines are staked out on the sides of another mine whose boundaries are already defined, because it appears that the vein inclines from the latter and may enter these side-claims, the Court shall protect these side-claimants and shall not permit the person who owns the mine from which the ore inclines, to follow the vein into these adjoining claims.

However, Article 30 also provided that if the boundaries of the mine from which the ore inclines are not already defined by the official survey and staking or if the ground into which the ore dips is not already claimed, then in either case the owner of the mine "shall be at liberty to continue to follow the said ore although he may go outside of his *pertenencia*." This latter provision clearly recognizes a limited exercise of the extra-lateral pursuit.

Ordinance XXX of the Spanish Mining Code of 1584, referred to by Gamboa as the "new ordinances," provided that if the ore in any mine shall be continuous with the ore of any other mine "and the two mines shall become one in the depth, the owner who shall have first sunk and made his way into the other mine, shall be entitled to the ore until the corner of the adjoining mine compels him to establish his boundaries. If it is found that he is outside of his true boundary he shall not draw, but he is still entitled to the ore he has mined

from the other's *pertenencia*, "inasmuch as he has acquired a right to it by the care and diligence used in working with more activity than his neighbor." The ordinance also provided that if a person took a *pertenencia* contiguous to the mine of another and there is no vein disclosed therein or if there is one and it contains no ore, but the claimant works "merely with the intention of profiting by the ore of his neighbor when he shall get within his boundaries" he acquires no rights "even though his neighbor's ore should take its course within his *pertenencia*; and our mining judges and justices shall determine it so, and shall not allow or permit such mines, not being upon a vein or ore, to be worked."⁸ It is quite evident that the foregoing provisions create and protect a modified form of extra-lateral pursuit.

Gamboa comments that "Of all the ordinances contained in the new code, or the old law, there are none more difficult, or which have been more frequently the subject of litigation in the courts than this." He states that when the vein extends outside the *pertenencias* of adjoining owners into unclaimed ground, each owner is entitled to work freely through the virgin ground upon the dip of the vein beyond his own limits and whenever the workings of rival claimants in this common ground meet a *guarda-raya* or boundary monument should be established beyond which neither could pass. Cases of this character gave rise to extensive litigation and a famous contest arose in the mining district of Guanajuato where Count de San Pedro del Alamo insisted that the dip of the vein that apexed in his Santa Anita mine

"was infinite in extent," that "the vein was his property, as far as it extended upon the underlay as being one and the same vein; and that as, when the vein, being what is called a deep vein, proceeds perpendicularly downward, the miner may work on to the antipodes, or to the infernal regions, as Amaya says; so, if the vein be inclined, its whole extent upon the underlay is granted to the miner."

The miners of this district had previously contended that the surface limits alone were to be within prescribed boundaries but insisted that the miner might work to an unlimited extent underground, whereupon in 1739 an order was issued that the property of the vein is not granted to an indefinite extent on the dip and that the underground limits of the mine must correspond vertically with the surface boundaries. The only exception is that already noted which permits a miner to follow a vein into unclaimed ground.

The early Spanish mining laws applicable to Peru provided that "if the principal vein of a mine should take its course without another's limits, it may be followed up without any impediment." If a vein divided before taking its course within the boundaries of a neighborhood mine, the owner was required to select one of the branches as his principal vein which he could fol-

⁶ Gamboa, op. cit. *Ord. and Code Mining*, *Golden Age*, 17, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.

⁷ Mining Law of Spain & Mexico, Hallett, 1870, p. 12.

⁸ Hallett, op. cit. Gamboa, pp. 14-15.

low into his neighbor's ground. Gamboa notes that these regulations conform to the practice in the mines of Germany.

The ordinance of 1783 materially changed the Spanish mining law.⁹ Article I of Title VIII states that uniformity of size of surface claims cannot be observed underground and at the same time equality between claimants preserved, for the inclination of the vein with the plane of the horizon makes the amount of vein-material included within the *pertenencia* greater or smaller and it may well happen that when a miner after great expense and labor reaches the boundaries of his claim where the vein begins to be rich, an adjoining owner, who has placed himself at that point with more cunning than labor, may compel him to stop working further "so that from this arises one of the greatest and most frequent causes of litigation and dissension among miners."¹⁰ As a result, the new code provided that each miner is entitled to 200 Castillean *varas*, which are called *de medir* (long or running measure) along the thread, direction, or course of the vein taken on a level. To square the claim a rectangle was formed by taking 100 *varas* on each or either side of the vein, if the vein were vertical, and this width increased as the dip of the vein might flatten till the claim attained a maximum width of 200 *varas* for veins dipping at an angle of 45° or less. The ordinances voiced the opinion that by the time the vertical boundaries of the claim were reached the vein will have been considerably exhausted.

Article 14 referring to the permission granted under the former law of 1584 to enter another mine and continue following the vein until the owner of the other mine can extend his workings so as to stop the adverse entry, states that it is "the most fruitful cause of the bitterest law-suits, dissensions, and disturbances among miners" and the adverse entry occurs more often through fraud or accident rather than as the result of merit or industry. Therefore, entering the *pertenencia* of another is prohibited.

Article 15 provides for an exception, however, and if a miner pursuing his working fairly and following his vein reaches the *pertenencia* of another or discovers there a vein undiscovered by the adjoining owner, he shall be obliged to give such adjoining owner immediate notice and thereafter share equally with him all that he may extract from the adjoining *pertenencia* and for failure to give such notice of invasion of the other's territory he lost all right to the ore taken out and also paid double its value as a penalty. The other owner could stop this invasion at any point that his own workings encountered the invader's.

Article 16 continued the right to follow the vein into

unclaimed adjoining territory but compelled the denouncing of a new adjoining *pertenencia* covering the vein.

Article 17 confirmed each owner to that portion of the vein included within his boundaries and specifically denied the right either to the discoverer of the vein or to the owner of the apex to "claim it in its whole extent, or wherever it may happen to be."

This was the mining law in force in Mexico from 1783 up to the time of discovery of gold in California. Raymond¹¹ makes the comment that

"this law is remarkable for an attempt to reconcile the two systems of square and inclined locations by an elaborate graduation of the size and shape of the surface claim according to the dip of the vein."

He points out the impossibility of administering such a law in accordance with the facts, for an opening 10 yards deep was required to determine the dip of the vein, which was then erroneously assumed to follow a uniform course and dip.¹²

The ordinances of 1783 have long since been superseded by mining codes which have abolished the graduated forms of claims.

AUSTRALIA. The local court regulations of Maldon of March 6, 1857, provided that the width of a claim should be 100 feet on each side of the line of the 'reef' with the dips and angles of all 'reefs' within the boundary and the right to follow them to whatever distance they might dip.¹³

In New South Wales the mining regulations of August 5, 1858, provided that:

"Miners occupying any portion of a quartz reef or vein shall be entitled to follow and work it in any direction that such reef or vein may take. . . . Provided, . . . that when any reef, vein, or bed of quartz shall lie nearly horizontal, or at a less angle with the horizon than 20°, the holder of any claim shall be only entitled to follow such reef, vein, or bed of quartz in the direction of the dip, for a distance not exceeding 50 yards from the point where they commence to sink in search of any such reef, vein, or bed of quartz."¹⁴

These extra-lateral provisions were probably patterned after the miners' customs of California, since Californian miners are known to have taken a leading part in this early mining in Australia. The use of the terms 'dips and angles' is similar to language employed here by the early miners. Where the vein was inclined, the limits of

⁹Mineral Resources (1869), p. 196.

¹⁰*Ibid.*, p. 198.

¹¹Law of Gold Mining in Australia and New Zealand, Armstrong (1901).

¹²If this provision was not suggested by the Germanic extra-lateral law, it is at least the strongest kind of circumstantial evidence, for in most of the mining districts of Germany veins that dipped at an angle of less than 20° were termed *flütze* and no extra-lateral right could be acquired to such deposits.

¹³See, 'Mining Laws of Australia and New Zealand,' Veatch (1910).

⁹These ordinances are set forth in full in Halleck's 'Mining Laws of Spain and Mexico,' pp. 189-315.

¹⁰In the light of recent criticism of the extra-lateral right, it is amusing to note that this ordinance attributes excessive litigation to the inflexible vertical boundary system. Dissatisfaction with existing conditions and enthusiastic conviction that a change will result in complete relief, is a common characteristic which is not confined to the present day.

a claim were determined by establishing a base-line passed through the 'peg' or discovery-point on the apex of the vein and "another point visible and as distant as possible on the known line of the reef" or in case the position of the reef (vein) was not sufficiently known, an arbitrary point was selected and from this base-line right-angled lines were extended out in the direction of the dip of the vein. This method of defining boundaries within which the miner could work is almost identical with the plan that was later adopted on the Comstock lode for the settlement of disputes over boundaries.

In 1862 the regulations were altered so that a claim had a width of 100 yards and the owner was entitled to all veins found therein, instead of one vein only as under the former act, and could follow any vein into unoccupied ground.¹⁶ In 1866 the system of vertical boundaries was adopted because the extra-lateral system was "found to lead to disputes."

In Western Australia under existing law, individual leases are granted of areas necessary to work the vein to a depth of 3000 ft. and if the mineral is gold the length along the outcrop of the vein shall not exceed 66 chains, and if mineral other than gold the distance along the outcrop shall not exceed 90 chains. This right to mine in depth is virtually equivalent to the exercise of an extra-lateral privilege.

RHODESIA. All property in minerals and mining rights in Rhodesia has been granted by the Crown to the British South Africa Company. The system of mining law in force there was adopted in 1903 and is largely copied from the American law.¹⁷ A 'reef claim' is a parallelogram 150 ft. long on the course of the vein with a width of 600 ft. at right angles to the length. A 'block' is a group of not to exceed 10 contiguous claims, thus forming a parallelogram 1500 by 600 ft., the exact size of a lode-claim under American law. The 'extra-lateral right' is defined in the ordinance to be "the right of following a reef on its dip in any block beyond the limits of the vertical block." The "course of a reef" is defined to be a line on the surface marking the intersection of the centre of the reef with such surface. If the reef were 'blind,' that is, situated below the surface, the points where it approached closest to the surface were projected vertically upward. This is the 'course of the apex' or 'lode line' of the American law.

The miner had the "extra lateral right of pursuit of such portions of his discovery reef on its dip outside the limits of his vertical block as are comprised between vertical planes indefinitely extended and passing through the end lines of his block."¹⁸

BRITISH COLUMBIA. The various provinces of Canada have adopted the vertical boundary system of mining law but British Columbia in 1891 passed a Mineral Act, Section 31 of which provided that:

¹⁶Here we have a provision similar to those contained in the Spanish mining codes already noted.

¹⁷"Mining Law of the British Empire," Alford (1906), p. 197.

¹⁸The striking similarity of this law to the American mining law is evident.

"The lawful holders of mineral claims shall have the exclusive right of possession of all the surface included within the lines of their locations, and of all veins, lodes and ledges throughout their entire depth, the top or apex of which lies inside of such surface lines extended downward vertically, although such veins, lodes or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side lines of such surface locations," etc.¹⁹

The section also provided that if a location were laid crosswise of a vein instead of along its course the locator secured only so much of the vein or lode as it crossed and the side lines became the end lines for the purpose of defining extra-lateral rights. A location was deemed to be laid crosswise when the angle made by the centre line of the location and the general course of the vein was greater than 45 degrees.

This section of the Act was repealed by Section 2 of the Amendment Act of 1892 which provided that "The owner of a mineral claim shall be entitled to all minerals which may lie within his claim, but he shall not be entitled to mine outside the boundary lines of his claim continued vertically downward." Sub-section B preserves rights of locations under the former acts.

As a result of this brief period during which the extra-lateral right was sanctioned, rights to a number of such mining claims became vested. The British Columbia reports indicate that several cases have arisen where these rights are involved.

Sufficient examples have been presented to indicate that there has been a powerful tendency at work based on fundamental reason and natural law to segregate the mineral-bearing vein from the surface, and to grant the vein to the miner. Instead of confining him to inflexible surface boundaries extended downward vertically, the tendency has been to make these boundaries more elastic so that he could, in the interest of economy and justice, follow down on his vein, which is the principal thing sought, and which has no logical relation to the overlying surface. The surface ownership was usually segregated from the underlying mineral and vested in another who might be devoting it to agricultural or other pursuits. This severance is in line with the highest economic use of natural resources and embodies the modern conception of conservation. The surface was frequently used for convenience in marking out a perimeter merely to place a limit on underground workings, but the perimeter could be varied or extended according to the nature of the deposit, and as underground development might indicate was most equitable and economic. Frontage claims also accomplished the same object.

The pure type of extra-lateral right has unquestionably given rise to a vast amount of litigation, and this fact has resulted in its abolition in most countries where it formerly existed.

¹⁹This is identical in language with the Act of 1872, p. 2322, U. S. Rev. Stat. from which it was unquestionably taken.

The Prospector's Field-Work

By Herbert Lang

It appears likely that the question of what shall be done for or to our mining prospectors will have to be settled by the prospectors themselves. It is generally conceded that the day of discovery is past, the prospector must settle down to the more prosaic life of grubbing within restricted areas. Life generally is getting prosaic, so he need not complain. The feverish charging about from one country to another, from Cape Nome to Cape Horn, and making startling discoveries on a diet of 'sow-belly' and 'self-rising' is out of date. Probably the prospector himself will realize that he must harmonize himself with the sobered spirit of the age and bring his exertions into conformity with it. One of the principal demands today is for thoroughness and accuracy, in which respects the average prospector has much to learn. Necessity will compel him to do his work more thoroughly, covering with more pains a much more restricted area, and recording with more care what he may see. While his chances of making sometime a great discovery are, as generally conceded, becoming more slim each year, there is compensation in the largely increased opportunities of making small finds, in consequence of so many of the minor minerals coming into use.

What is required now is the careful investigation of comparatively small areas, and the recognition of all mineral occurrences of probable value. This must ultimately be done either by the Government geologist, the professional engineer, or by the volunteer prospector—or more likely, by the combined energies of all of them. Think of the sad waste of energy involved in desultory traveling over vast areas, travels that are repeated time and again by other prospectors, and engineers also, in misdirected attempts to find a mine. Hundreds of men follow in each others' footsteps without having received a single idea from their predecessors, and without leaving a shred of information to their successors. Nor is this waste of effort confined to prospectors: engineer after engineer, 'expert' after 'expert', follows in the never-ending quest, without any useful result to the public and with little gain to themselves. In this connection the important question is how to make the observations and findings of the more intelligent of the travelers of avail to the general public interested in these matters.

It seems to me that proper prospecting should be looked upon as a matter of public concern, to be fostered by the counties, States, and the Government. Your correspondents have made various suggestions, looking mainly to the private employment of this class of men, regardless of the patent fact that the revelation of mineral deposits is really a matter of public concern. The

Government is beginning to realize this fact, and the various States do something in this direction; but the State and National authorities thus far have merely laid the foundation for a thorough study of mineral deposits. Now, there is a vast mass of unpublished knowledge about particular areas and particular deposits that ought to be made accessible, to the end that the willing investor may know where to go without the wasteful and generally ineffectual process of sending a special representative here and there, to run down vague rumors and sift the reports of interested and too often unreliable parties. I can think of no better way than for communities to club together and hire qualified men to critically examine the lands about them and record carefully their findings, which, if the work is well done, will become a part of the stock of scientific and practical information upon which the mining industry will thrive. The geology of the country has been fairly well sketched, and a mass of miscellaneous facts collected in various ways by professional and other persons, and now if to this groundwork can be added in elaborate detail the descriptions of individual deposits the work will be in a measure finished.

The prospector may find his billet in this, but in order to perform such work properly he will have to fit himself in a different manner. He will need instruction. He will have to make himself conversant with mineral appearances. He should know somewhat of mineralogy, almost a sealed book to the wanderers of the past. The ability to test and determine minerals should be a part of his education, and involve some knowledge of chemistry. Without necessarily being a professional chemist, he should at least have some knowledge of assaying also. These things are not difficult to learn, and it has always been a matter of surprise that prospectors heretofore have been so regardless of the advantages of knowing how to make the simple tests indispensable to the proper performance of their tasks. A blow-pipe outfit, sufficient for such needs, may be carried in a suitcase, and if in addition to this more apparatus is thought to be essential, the whole weight and cost of materials would be no great matter. I would not minimize the trouble of learning the proper use of analytical or other scientific appliances, but I have never thought of assaying or blow-pipe work as anything but simple. People who, like miners and prospectors, constantly work in or upon minerals, surely ought to be able to tell them apart; but how often do you meet one competent to employ the commonest test to indicate the composition of a mineral? With every opportunity and inducement to become skilled in geology and mineralogy they continue in a state of comparative ignorance that would discredit a

schoolboy. Some men will work ten years in the mines and still be unable to tell you the difference between quartz and calcite, they will still divide all rocks into granite, lime, and porphyry, call all blue minerals 'bromides,' and prate about 'true fissures' as long as anyone will listen to them. I do not, however, hope to improve this state of affairs radically, for it would be as hard to get an old-time prospector or miner to learn anything out of books as it would be to get a young mining graduate to cease calling himself an engineer. I have often, but with what result I know not, advised young graduates to set up in some recognized mineral locality, and while working as the local assayer and surveyor make a close examination of all the mineral resources in the neighborhood—an examination that in the nature of things might take several years; but the time would not be lost even if no profitable discoveries rewarded the seeker.

My solution, then, of the question of what to do with the prospector would be to convert him into an examiner of mines, or, more strictly speaking, into an investigator of mineral deposits, and keep him at work in one spot. I would make his work available to the multitude by compelling him to keep accurate notes on what he did, and

I would have these notes published at the public expense and kept for the use of the mining industry. I would have the data regarding every mineral deposit in this State put into proper form for reference. It should be the habit of every qualified person, when he visits a mine or a prospect, to fill out a blank with the bottom facts concerning that mine, and to file the notes with a public official. Furthermore, I would see to it that every visitor to a mine, such for example, as our peripatetic experts, contribute his share to the sum of information. Taken as a whole, I do not regard the ordinary mining report as of much value, but he would be but a poor observer who did not find out at least a few useful facts in his peregrinations. By such means I should hope that in time the presumed necessity for both prospector and expert would have largely disappeared, and the mining industry have been placed upon a more secure foundation.

NITRATE PRODUCTION of Chile during August was 5,396,981 quintals of 101.4 lb. each, of which 4,338,013 was exported. In this month of 1915 the total output was 3,443,409 quintals. The present rate is equal to the normal quantity as in 1913.

Milling and Cyaniding Costs at Grass Valley and Nevada City, California, in 1915

By R. E. Tremoureaux and F. A. Vestal

A comparative cost sheet has been worked out by us on the following mills and cyanide plants:

Mill	Ore Stamp-		Stamps		Company
	crushed, duty,	tons	No.	Lb.	
North Star	51,830	3.8	40	1950	North Star Mines
Central	58,030	3.9	40	1950	" "
Champion	38,850	1.97	20	1950	" "
Empire	81,850	4.8	40	1950	Empire Mines
Pennsylvania	29,500	1.9	20	1950	" "

*Changed during the year

	MILLS				
	Empire	North Star	Central	Champion	Average
Tons	81,850	51,830	58,030	38,850	52,630
Labor	0.158	0.237	0.210	0.217	0.201
Supplies	0.070	0.127	0.111	0.079	0.092

*Total tonnage treated

	CYANIDING				
	Empire	North Star	Central	Champion	Average
Labor	0.112	0.116	0.113	0.118	0.114
Supplies	0.168	0.150	0.153	0.188	0.170

ASSAYING AND REFINING

Labor	0.013	0.022	0.021	0.017	0.018
Supplies	0.019	0.013	0.012	0.022	0.018
Power	0.153	0.153	0.153	0.153	0.153
Totals	0.085	0.188	0.186	0.192	0.187

Power-costs were not obtainable for the different mills and plants, so an average cost was taken.

CYANIDE LABOR—COST PER TON

	Empire	Central	North Star	Champion	Pennsylvania	Average
Foremen	0.014	0.028	0.031	0.039	0.020	0.026
Cyaniders	0.097	0.105	0.081	0.101	0.129	0.103
Sundry	0.001	0.002	0.004	0.008	0.002	0.003
Total	0.112	0.135	0.116	0.148	0.151	0.132

CYANIDE SUPPLIES—COST PER TON

In figuring the costs per ton, the following prices per pound were used: cyanide 22.5c., zinc 7.3c., lime 0.8c. All prices are for mine. Sundries include all supplies used except cyanide, lime, and zinc.

	Empire	Central	North Star	Champion	Pennsylvania	Average
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Cyanide	0.17	0.13	0.12	0.17	0.16	0.147
Zinc	0.20	0.19	0.20	0.17	0.20	0.21
Lime	3.20	3.80	3.6	3.8	5.10	3.98
Sundries	1.6	1.1	1.1	2.3	2.4	1.8
Total	5.17	5.32	5.02	6.44	7.46	5.56

Ore-Sampling Conditions in the West

By T. R. Woodbridge

*An accurate knowledge of the constituents of an ore is indispensable to the success of all mining enterprises, especially when the ore is sold to a custom plant of any kind. A large part of ore sampling is not done on a scientific basis. In most sampling-plants there is a lack of uniformity of methods. The Bureau of Mines has investigated the subject with a view to increasing efficiency in the operations. In California, Colorado, Montana, Nevada, Utah, and Washington, 48 plants were visited, sampling ores of gold, silver, lead, copper, and zinc.

Ore in place in a mine is rarely of uniform metal-content, and the process of extraction generally aggravates this condition, as the more heavily mineralized parts usually break-up more readily, so that the finer particles contain more of the valuable constituents than the coarser ones. With every crushing during sampling this difference persists to a varying degree, even after the final lot has passed 120-mesh. In considering the reliability of any sampling method the tendency of the ore to segregate should not be forgotten. In a large proportion of systems used in the Western States the theory of sampling has been given proper consideration, and many plants are operating on correct principles.

Where the more valuable ores are sampled it is often customary to divide the sample at certain points in the process, and make duplicate, triplicate, and even quadruplicate samples, each of which receives an entirely independent but similar treatment during the later process, and is assayed separately. This checks errors and gives an average for settlement with sellers of ore.

Ore is generally weighed on platform-scales, varying in capacity from 60 to 100 tons. Weighing has improved considerably during the past 10 years. Scales are frequently tested by the Western Weighing Association. Weighing is generally carefully done, but undue haste was noticed in some instances. The weighing of a slowly-moving train of cars coupled together is not now in vogue, the Association stopping the practice. If horses are straining at a loaded wagon being weighed, several hundred pounds may be added to the net weight.

Low-grade and uniform ores that will not stand the cost of a more exact method may be sampled by the 'grab' system, whereby small quantities of ore are taken at random by hand or a shovel from the pile or car. Careful men obtain fairly accurate results in this manner. Pipe sampling can be used for fine material only. Neither of these methods were found to be in general use, and are rarely suitable for ores.

Coning and quartering is practised exclusively in two of the plants, and in combination with other sampling

methods in twenty-six others. Advantages claimed are that an expensive equipment is not required, the method can be used where mechanical apparatus is not procurable, it is applicable to all kinds and conditions of ore, it may be used for high-grade lots without loss, and as the ore is in sight of the seller all the time the system often pleases him. Fig. 1 shows a plant that includes

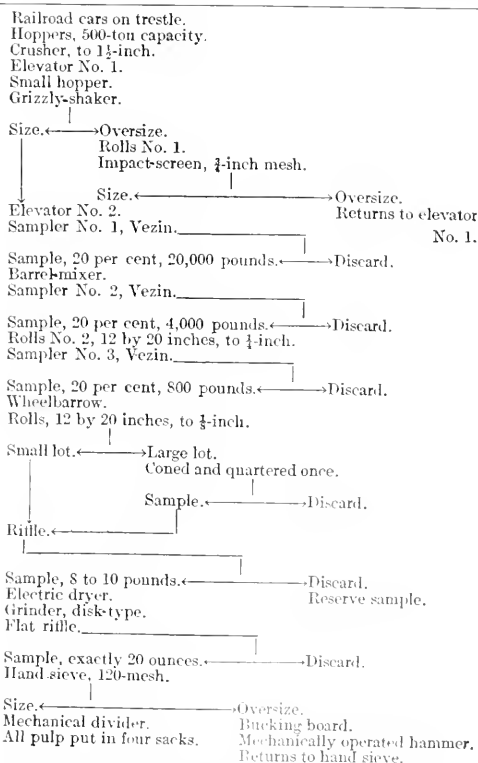


FIG. 1. SAMPLING-PLANT THAT INCLUDES CONING AND QUARTERING.

coning and quartering. There are numerous disadvantages as it is expensive, time is lost, and salting is possible.

In coning operations, or forming a cone on a floor, a rough separation of fine and coarse particles takes place, even when the ore is finely crushed. Uniform mixing of various sizes is impossible. During flattening of the cone for subsequent quartering, care is necessary not to aggravate the segregation of particles. By the 'bench' system, in which a number of cones are spread out each

*Abstract from Technical Paper 86 of U. S. Bureau of Mines.

time above one another, segregation is lessened, but the trouble is still evident.

None of the plants examined used the fractional shoveling method of sampling exclusively, but all of them using coning and quartering and six part-mechanical plants use shoveling at some point in their operations. By fractional shoveling is meant every second or tenth shovelful of a lot of ore is thrown into a special receptacle for sampling. It is a convenient method, but is no more reliable than coning, and also men shoveling at high speed are not likely to be accurate in counting.

Many advantages are claimed for mechanical sampling systems. Save for cleaning the machines and unloading ore, no hand labor is necessary. The operation is continuous and fast. With proper precautions the susceptibility to error and manipulation in hand methods is eliminated. All custom sampling-plants employ the mechanical system. One plant can compare its system with others to which ore is forwarded. A well-conducted custom plant studies comparative returns from different smelters and mills, and frequently makes shipment of 'split lots' of the same ore to two or more reduction works. Re-sampling of several consecutive portions of the same lot of ore is a practice, the lots being sent to as many different smelters for comparison of results. The custom plant does not buy all the ore it samples, but usually does a large proportion of its business in what is termed 'sampled-in-transit' ore, the sample obtained to act as a check on the assay given by the purchasing-plant. Many objections are made to mechanical sampling, as the initial cost and renewals are heavy, dust may salt samples, machines are difficult to clean thoroughly, and improperly constructed spouts or other apparatus might prevent good sampling.

Devices for mechanical sampling operate on either of two distinct principles that separate them naturally into two classes—stationary devices which continuously divert certain fixed sections of the stream of ore for the sample, and moving devices which are so operated that during several fixed periods per minute, they divert the whole of the moving stream of ore for the sample. These devices are commonly and more graphically described as those taking part of the stream all the time, and those taking all of the stream part of the time. The first class of the mechanical samplers now in use is represented by the whistle pipe and the bank or combination riffle. In the former the ore is fed into a vertical iron pipe with five notched openings cut half way through it, each at an angle of 90° from the one immediately above. Above each notch is a cast iron liner, which diverts half of the ore each time to a reject bin. The sample represents $\frac{1}{2}$ of the original feed. The device is a good one, but the ore cannot be re-crushed until it has passed through and is then $\frac{1}{32}$ of the original bulk. The bank or combination riffle consists of five riffles set in one frame, the top riffle being placed over two lower ones which are in turn followed by two more set below them. The ore is fed from a chute or hopper to the first riffle, where the stream is divided into a number of smaller streams, which are

other one falls on one side and the rest on the opposite side of the riffle. From the spouts on both sides of the first riffle the streams of ore impinge on inclined iron aprons, *k* and *k*, by which they are diverted to the two riffles *cd* and *ef*, smaller than *ab*, and so on, as shown in

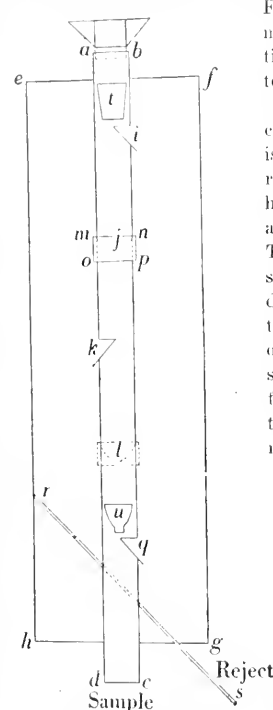
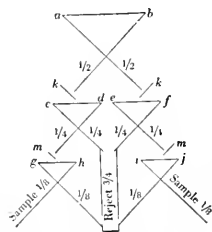


FIG. 2. WHISTLEPIPE AND BANK OR COMBINATION TYPES OF SAMPLING-APPARATUS.



ore falls into the reject receptacle. This type has some special advantages in addition to those already ascribed to mechanical samplers. The more common examples in use at the plants visited are the Snyder, Vezin, Chas. Snyder, the Brunton vibrating, and the Brunton oscillating machines.

The Vezin is used at 25 of the plants, and is used in combination with almost every present method of sampling. Details of construction have been changed at many plants, but the principle remains the same, and in its simplest form is as in Fig. 3. The sides of the sample-spout should be vertical, the top edges should be inclined at an angle of approximately 58° to the horizontal, and should deliver the ore in a sheet parallel to the edges of the spout as they pass beneath it, and that the sampler should be so rotated that the speed of the sample-spout should approximately equal the horizontal speed of the ore when it reaches the spout.

In Fig. 4 are shown the Brunton vibrating and oscillating samplers. They are used at two and six plants, respectively. The illustrations are self-explanatory. In the oscillating machine as many as 72 samples per

minute may be taken. Care must be taken in the design of this apparatus.

Synchronism takes place in mechanical samplers, and when two or more machines are operated as a train or in series there is necessarily a constantly recurring cycle of their relative positions. For instance, if two hori-

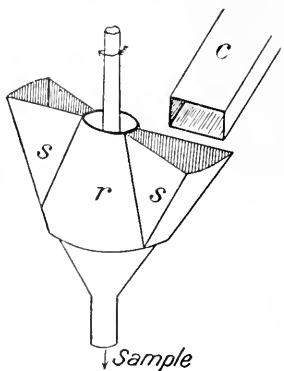


FIG. 3. A VEZIN SAMPLING-MACHINE.

izontally rotating machines are so placed that one is directly beneath the other, and are given the same speed of rotation, the sample spouts will always keep the same angular distance apart. If the machines are given different speeds, the sample spout of one will catch up with

metallies, fineness, weighing, salting, and comparison of assays.

The paper concludes with flow-sheets of 55 sampling systems at the 48 plants investigated. The general form

For large lots, 500,000 pounds or more.

Grizzly.

Crusher No. 1, 24 by 36 inches, to 5½-in. h.

Inclined conveyor belt.

Sampler No. 1, Vezin.

Sample, 10 per cent, 50,000 pounds. → Discard.

Shaking tray.

Crusher No. 2, 15 by 21 inches, to 2-in. h.

Angled spout.

Sampler No. 2, Vezin.

Sample, 20 per cent, 10,000 pounds. → Discard.

Inclined conveyor belt.

Covered steel hopper.

Long shaking tray.

Rolls No. 1, 16 by 42 inches, between 1 and 1½ in. h.

Chute.

Inclined conveyor belt.

Hopper.

Sampler No. 3, Vezin.

Sample, 10 per cent, 1,000 pounds. → Discard.

Long chute.

Conveyor belt.

Hopper.

Shaking tray.

Rolls No. 2, 12 by 20 inches, between 1 and 1½ in. h.

Chute.

Inclined conveyor belt.

Hopper.

Sampler No. 4, Vezin.

Sample, 20 per cent, 200 pounds. → Discard.

Long chute.

Conveyor belt.

Rolls No. 3, 12 by 20 inches, set close.

Hopper.

Compound riffles, on track. Omitted as desired.

Sample, about 125 pounds. → Discard.

Put in canvas sacks.

Taken to bucking room.

Bucking room.

Hand sieve, 8-mesh, product drops on floor.

Size.

Over-size.

Roll, 10 by 20 inches.

Product drops on floor.

Shoveled over to mix.

Flat riffle No. 1, placed over shallow pan.

Sample, about 8 pounds. → Discard.

Small flat riffle, No. 2.

Sample, about 2 pounds. → Discard.

Steam drier.

Grinder No. 1, disk type.

Sieve, 100, 120, 150, and 150 mesh.

Size.

Rolling cloth.

Flat riffle No. 3, on shallow pan.

Too many sacks of pulp as desired, balance discarded.

First residue to grinder No. 1.

First residue to bucking board.

Returned to sieve.

FIG. 5. FLOW-SHEET OF A LARGE SAMPLING-PLANT.

of the flow-sheets is a modification of that used by D. W. Brinton in his 'Modern Practice in Ore Sampling.'*

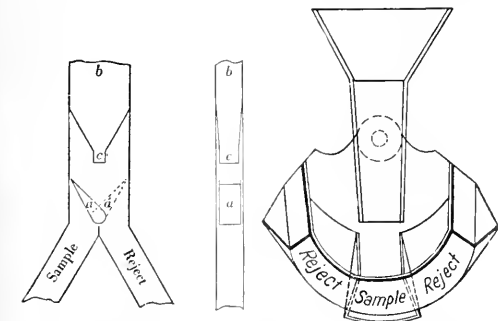


FIG. 4. BRUNTON VIBRATING AND OSCILLATING SAMPLING-MACHINES.

and pass that of the other with a regularity like that with which the minute hand passes the hour hand of a watch. Mills have been entirely re-constructed to avoid this condition. An elevator or Chas. Snyder sampler lessens the trouble, but the better system is to interpose between the samplers a hopper, a revolving barrel, or a shaking tray. Eight plants use the barrel-mixer, 19 the tray, and 6 both systems.

The final work of sampling includes the drying, grinding, and sacking of the sample after it has reached the bucking-room. Fig. 5 shows a large sampling-plant, the latter part of which explains reduction of samples to the final lot for assay. Much care is needed in the various operations of drying, grinding, screening, treatment of

THE IDEA seems prevalent among men operating small properties in Arizona that the smelters and custom mills have, in many cases, given false returns on ores that are sent in for smelting and treatment. With a view to ascertain the facts of the case, the Arizona State Bureau of Mines has conducted an investigation and has found that it would be quite impracticable for any smelter or mill to so falsify its method of sampling as to give low returns and still give the shipper one-half of the sample to allow check-assays to be made. Bulletin No. 26 of the Bureau, entitled 'Mill and Smelter Sampling,' by H. J. Stander, was written with the idea of showing the small shipper how to sample, so that he may sample his ores before shipment to ascertain the correct value, thereby having a check on the smelters.

*Trans. A. I. M. E., Vol. 40, 1909.

Concentrates

Answers of the MINING and Scientific PRESS to questions and give information dealing with the various phases pertaining to the practice of mining, smelting, and concentrating.

THE MELTING-POINT of copper is 1100° C. (2012 F.); that of aluminum, 655° C. (1211 F.).

BARYTES is used principally as a pigment in mixed paints and in the manufacture of lithopone, a white pigment.

BLACK DAMP is defined by the U. S. Bureau of Mines as an accumulation of carbon dioxide and nitrogen in excess of the percentage found in pure atmospheric air.

POTASH is being recovered as a by-product in cement manufacture. Waste dust, which contains considerable potash, is precipitated by the Cottrell electrical process.

THE LACE-HOLES in a belt reduce its strength by at least 25%. Care must be taken not to make a bulky splice which prevents the belt from passing smoothly over the pulleys.

BLACK HOLING in breaking boulders is more efficient than mud-capping which is so commonly used. The former requires less explosive than the latter but requires more time.

CEMENT GUNS have been used to close crevices on the surface where water enters mines during the rainy periods. Work must be done when crevices are dry as the gun will not operate against flowing water.

"SALE PRACTICE AT BLAST-FURNACES," a manual for foremen and men, by F. H. Wilcox, is the title of Technical Paper 136 issued by the U. S. Bureau of Mines. A valuable lot of practical suggestions and warnings are given.

THERE are numerous sections of land in the Western States, owned by the railroads, where these sections are sometimes many miles outside of the zone of 20 to 40 miles lying on either side of the railroads, and in which the railroad companies own all the odd-numbered sections by grant from the Government. These outside sections are lion lands selected by the railways in place of those sections within the zone of the grants, which, for one reason or another, were expected from the original grant and to which the railroads were unable to obtain title.

ZINC and production of the United States in 1913 was 516,000 lb. while imports were 1,321,750 lb. Since the War started, Europe supplies have been cut off and at Salt Lake City, the U. S. Bureau of Mines, which is experimenting on the treatment of bottegosh complex zinc lead ores, and prospect, have been determining

whether the zinc in such ores could be produced as dust from solutions of zinc. H. J. Morgan and O. C. Ralston, in a paper prepared for the American Electrochemical Society, concluded that by depositing a sponge metal from solutions by electrolysis it is possible to get a zinc product that on drying crumbles into zinc-dust. The sponge is obtained from zinc-sulphate solutions, also chloride solutions.

THE FIRST DREDGE-BOAT for gold built in the West was on the Feather river, near Oroville, in the summer of 1878. It was not a paying investment nor a mechanical success. The boat was 60 ft. long and about 30 ft. wide. The gravel was elevated by creating a vacuum in a stand-pipe connected with a tube the lower end of which was in contact with the bottom of the river. This was done by injecting a jet of steam into the stand-pipe and then a stream of cold water to condense the steam. The tube was raised by mechanical means and the gravel dropped into a sluice-box for washing. The bottom of the river was so uneven that the suction was not great enough to remove the gold from the crevices.

TESTS recently were made to determine the relative resistance of iron, steel, and a number of alloys, to atmospheric corrosion. Taken as a whole the results indicate that copper-bearing steels are superior to any of the other materials tested. It was found that pure iron, including charcoal iron, is more resistant than the ordinary steel but that the addition of 0.25% of copper to the steel causes a remarkable increase in its ability to resist atmospheric corrosion. The addition of copper to pure iron also results in an increased resistance but not to the same extent as the addition of a similar amount to steel. It is believed that the copper exerts a greater influence in the steel than in iron, due to the combined presence of copper and manganese since the chief difference in iron and steel is in the manganese content. The exact function of this combination in the alloy is as yet not clearly understood.

IN LOCATING mining claims the locator should endeavor to ascertain if possible the direction of strike of the vein or orebody and lay out the claim in the direction of this strike. Failure to give proper attention to this important matter may eventually prove to be expensive, for the exercise of the extra-lateral right is directly affected by the relation of the strike of the orebody to the side lines of the mining claim. In the case of a vein the direction of strike is generally apparent, but where the orebody is irregular in form it is often puzzling to determine the strike before considerable development work has been done. Often, where orebodies are large and irregular in form, giving little evidence of strike in any direction the formation in which the ore deposit occurs may be observed to have a strike, due to schistosity, or sheeting, or the strike may be determined by the dip of the strata. When this strike of the rocks can be ascertained it will usually be found that the orebody conforms approximately to it.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

DEADWOOD, SOUTH DAKOTA

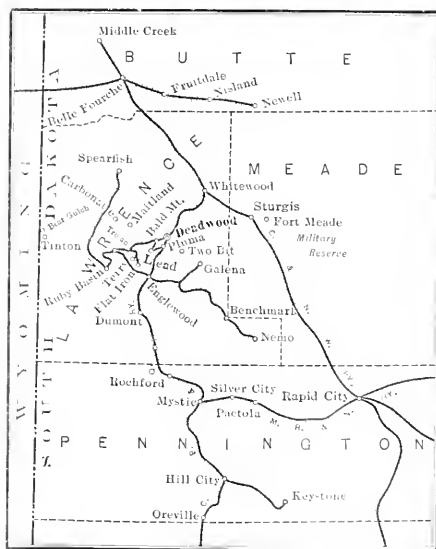
TUNGSTEN DEPOSITS DESCRIBED.—GOLDEN WEST AND SLAVONIAN MINES.—HOMESTAKE'S NEW HOSPITAL.—THE BLACK HILLS SUMMER SEASON.

As has been pointed out in these letters, the principal tungsten ores of the Black Hills contain the mineral wolframite; some scheelite has been found. In the Bear Gulch district scheelite is almost invariably found, in small quantities, in the placers. It is hardly rich enough to save except as a by-product of gold mining. Wolframite, though, is found in three distinct geological formations. It occurs in quartz veins in the schists, notably in Pennington and Custer counties; in pegmatite dikes in those counties, and in and adjacent to the Cambrian quartzite in some portions of Lawrence county. In the past few months the available supply of wolframite ores has been materially increased by new discoveries. One of the most important of these finds is that of W. L. Faust and associates. Their property, in Harney canyon, south of Hill City, shows an immense pegmatite dike that gives promise of developing into a large supply of tungsten ore. Some rich specimens have been found, but the average grade of the ore, when mined in large quantities, would probably not be above 2%. In the neighborhood of Deadwood a number of tungsten discoveries have been made. This ore occurs in intimate association with the Cambrian quartzite. At times it is found in the quartzite, and at other times immediately above it. Both classes of deposits are undoubtedly replacements of some of the limy or dolomitic ingredients of the quartzite and adjoining beds, by the tungsten mineral. Two miles south of Deadwood, near the head of Two Bit gulch, some of the finest ore yet found in the Black Hills has been taken out. Here the crystals of wolframite are unusually well developed. They often attain a length of $\frac{1}{2}$ to 2 in., and their structure—radiating groups of prisms—add attractiveness and make them valuable as specimens for collectors. Almost within the city limits of Deadwood, north-west of the business section, quartzite ores have been found that with a fair price for tungsten would make profitable milling schemes. During the past summer systematic prospecting has revealed a far greater extent of wolframite ore than was, prior to that time, believed to exist. High-grade, which could be profitably shipped any great distance, is not plentiful, and additional custom mills seem to be needed. But before they can be built contracts must be arranged so that a market can be assured for their product. Black Hills' miners would welcome and support a mill, conveniently situated, which would buy ore on a basis of around \$20 per unit.

After cross-cutting 170 ft. of vein-matter and 20 ft. of a slate horse, the Golden West management has decided to drift south on the vein for 100 or 150 ft. and cross-cut again. The disclosure mentioned was made in the adit, work on which was started last spring. At a point nearly 400 ft. from the portal the foot-wall of the vein was encountered. Further work in a westerly direction revealed the ore-formation described, but as yet the hanging wall has not been found. The south work will be in the direction of, and eventually immediately beneath, the open-cut from which several thousand tons of ore has been milled.

L. P. Dove and others (the former last winter was instructor in chemistry and assaying at the Lead public school) have had

a successful summer's run on ore from the Slavonian ground, near Elk mountain. They have been operating the Deadwood Standard mill, which is conveniently situated within a few hundred feet of their workings; but will probably suspend milling during the winter, and devote their energies to mine development. The ores that have been treated occur in one of the upper members of the horizontally-bedded Carboniferous limestone. This stratum is about 50 ft. thick, and is rather irregularly mineralized. Where exposed by erosion on the sides of gulches it often shows faces of ore 20 ft. thick, but when followed into the hill it gradually pinches until it is no longer profitable. The present operators have been confining



THE BLACK HILLS REGION OF SOUTH DAKOTA.

their efforts largely to outcrop ore. It is more abundant, easier to secure, and gives a satisfactory extraction in the mill.

The Homestake company has outgrown its hospital, a building constructed years ago, and has decided to erect a new and thoroughly modern structure on the Jentees corner, at Lead. The new hospital, equipped, will cost \$100,000. Dr. F. E. Clough, assistant surgeon, and A. J. Blackstone, of the engineering department, are now in the East making notes on the arrangement and equipment of modern hospitals. The Homestake hospital and medical service is maintained by the company, and is free to all of its employees and their families. The new building will make this uniformly excellent service even better than it has been in the past. Work will begin this winter or early next spring, as the plans will be prepared as soon as the investigators return.

Taken as a whole the Black Hills has experienced a prosperous summer, insofar as the mining industry is concerned. There has been more than the usual amount of development.

TORONTO, ONTARIO

MUNITION BUSINESS AND STEEL—ZINC AND COPPER BRITONS—
FORTHPIKE, NICKEL AND POLYMER.

Recent statements to the effect that no more orders for War munitions were likely to be given to Canadian manufacturers by the British government have been shown to be entirely unfounded, as an official announcement by the Imperial Munitions Board at Ottawa states that it has received instructions to place additional contracts to the value of \$60,000,000. The total value of the munition orders secured in Canada since the beginning of the War is \$350,000,000, of which contracts amounting to \$185,000,000 were awarded during the present year. The Imperial Munitions Board states that during July and August operations were delayed owing to the difficulty of procuring steel and forgings, but that conditions have since improved and the output of shells is increasing in number each week. The quantity of shrapnel shells now produced complete has reached nearly 250,000 per week. The difficulty in securing deliveries of the new equipment necessary for the manufacture of the larger size shells caused slow deliveries, but most of the plants required these installations are now in operation. No further troubles as to raw material is anticipated as arrangements have been made to secure all the steel required. The policy of the Board will be to confine new business to the plants already equipped and in operation. The steel industry is very active. Thomas Cantley, president of the Nova Scotia Steel & Coal Co., states that the company is now turning out steel billets at the rate of 15,000 tons per month or more than double the output of a year ago. He estimates the total output for Canada for 1916 at 1,500,000 tons compared with 975,000 tons in 1915, and 1,350,000 tons in 1914, which was the record year.

An extensive and rich zinc-copper deposit at Cape Breton, 30 miles north-west of North Sydney, Nova Scotia, is being opened up to the great demand for metals for the War. It has recently been secured by Toronto capitalists, whose representative, H. H. Sutter and Co., now in Nova Scotia making arrangements for development on an extensive scale. The surface indications are stated to be splendid. The main vein 10 ft. wide, has two branches, the first 10 ft. wide, and a second vein 10 ft. wide has also been traced for some distance. Assays of ore from the main vein are estimated to contain 34% zinc, 21% copper, 10% lead, and small quantities of silver contents. The owners have been offered contracts for large quantities of zinc, lead, and copper, and are anxious to secure permission to make shipments as soon as possible.

The recent four-weekly statement of the Dominion Consolidated for the period ending September 30 shows a gross profit of \$111,442 from the production of 10,000 tons of ore averaged \$8.94 per ton. The operating cost was \$3.87 per ton. The profit was \$18,147 below the \$129,589 reported for the same period for 1915. The total production for 1916 is 10,000 tons, and the average price received for the ore is \$11.97. The company's production of 10,000 tons is shown in the following table, which will be wiped out one day. No. 1 level, 10 ft. wide, has a short distance to the surface. No. 2 level, 10 ft. wide, has cut in 10 ft. of ore, which is a continuation of the main vein, and is 10 ft. wide. The 700 ft. level. The company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day. No. 1 level, 10 ft. wide, has a short distance to the surface. No. 2 level, 10 ft. wide, has cut in 10 ft. of ore, which is a continuation of the main vein, and is 10 ft. wide. The 700 ft. level. The company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day.

Owing to the shortage of 10 ft. wide, and the fact that the company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day. No. 1 level, 10 ft. wide, has a short distance to the surface. No. 2 level, 10 ft. wide, has cut in 10 ft. of ore, which is a continuation of the main vein, and is 10 ft. wide. The 700 ft. level. The company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day.

A contract has been let for the construction of a new shaft, drilling on the Thompson mine, which is a continuation of the main vein, and is 10 ft. wide. The 700 ft. level. The company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day.

The La Roca, which is a continuation of the main vein, and is 10 ft. wide. The 700 ft. level. The company's production of 10,000 tons of ore is shown in the following table, which will be wiped out one day.

high-grade vein, showing free gold. Machinery is being brought in from the old University mine at Cobalt. The same company has taken an option on the Hurd claims, Kirkland Lake.

The Davidson is sinking a new shaft on a vein recently found on its south lot, the ore extracted showing high gold content.

The Cobalt labor situation was summarized in the Press of October 14, so there is no need to cover the same subject again.

The nickel question is being kept well to the front as a political issue in the speeches of leading politicians, and public interest in it has been revived by the attendance of Lord Robert Cecil of the British government, who referred to the *Deutschland* episode as showing the need for greater precautions. The contention of the Hon. J. Howard Ferguson, Ontario Minister of Mines, that the nickel undoubtedly carried by the merchant submarine was not the product of Ontario mines, is not generally regarded as convincing.

SUTTER CREEK, CALIFORNIA

END OF THE STRIKE.—TWO WEEKS' PROGRESS AT THE OLD EUREKA.—SOUTH KEYSTONE, ST. JUNEAU, AND AMADOR STAR OPERATIONS.

The strike of Amador County miners is at an end and the men are returning to work. The evident intention of the Federal Court to prevent the Union's interference with the work, the importation of strike-breakers, and the desire of many of the men to return to work, are the reasons given for disorganization among the strikers. Without waiting for action by the Union, 30 men returned to work at the Bunker Hill mine on October 30. A mass meeting was called for Thursday forenoon at Italian Society park, at which only 150 of the expected 550 men were present. Then it was decided to hold meetings at Sutter Creek and Jackson on the evening of November 2, where the members of each Union voted on the question, "Are you willing to return to work under the conditions submitted by the mine operators?" The following results were made known at 10 o'clock Thursday night. The Jackson Union's vote stood 29 in favor of returning to work and 18 against, which was offset by Sutter Creek Union men voting 48 in favor and 14 against returning to work, the affirmative winning in the two meetings by 15 votes. The reason for the difference in the stands taken by the majority in the respective Unions is that the Kennedy and Argonaut are known to be yielding large dividends, so that the Jackson miners felt they were entitled to more consideration than the Sutter Creek miners cared to demand in view of the fact that Sutter Creek's principal mines have been on an assessment basis for many months and has just levied a 3-cent assessment to raise funds for sinking, and the South Eureka is said to be barely making expenses at the present time. The Kennedy mine, opened on the 3rd with 60 men underground, and the Argonaut, started with 20 miners, a small number compared with their usual crews of 300 and 200 respectively. More men are steadily adding to work, and it is understood that only those who took very active parts in the strike are being refused employment. The South Eureka arranged for the importation of strike-breakers. Richard Carlisle of the Merchant & Manufacturers Protective Association of San Francisco, established a mine on the 1st, 10 more arrived on the 2nd, and a third group on the 3rd. James J. Black, one of the men who had been found dead in bed Thursday morning at a hotel near the South Eureka, but who had been proved that he was a victim of a heart attack, was brought about by over-exertion and

The Kennedy mine usually employs about 100 men, and the Argonaut is shut down for one or two new levels below

3200 ft., the force will probably be increased. At present, that company is offering machine-men, \$3.25 per day; jigger-men, \$3; timber-men, \$3.25; skip-tenders, \$3.25; machine-helpers, \$2.75; carmen and muckers, \$2.75, being the same schedule applying since the voluntary raise of 25c. was made several months before the strike occurred.

At the Bunker Hill and Keystone mines in Amador City, the owners have made use of the cessation of the usual mining and milling operations to make extensive repairs to their surface plants, as well as in the shafts; the Argonaut company has gone ahead with its mill and tramway system during the strike; and the Kennedy has installed new boilers and enlarged its tailing dam, so the time has not been lost.

Despite encountering numerous caves in the shaft, and the necessity of straightening out a bend near the 800-ft. level, there has been fair progress made during the week in unwatering and re-timbering the Old Eureka shaft, the water now being down to a point about 850 ft. from the surface. The pumping system is working well, and by removing the hump or bend caused by too closely following the vein when this shaft was sunk, considerable inconvenience and expensive up-keep will be avoided in future operations. About half of the crew of 50 men is engaged in surface construction and preparations for the installation of the large hoist and steel head-frame. It is understood that H. L. Gooding, the head mechanic at this property, has resigned to accept a position in Colorado.

The old Eureka shaft has been unwatered and re-timbered to a depth of 830 ft., and far less difficulty is being experienced in clearing the shaft below the 800-ft. than was anticipated. The new 9000-gal. tank at the 500-ft. station has been completed, including the concrete work on that large reservoir. The pumps so far connected up are throwing a good stream, and good speed can now be made in re-opening this old producer. On the surface, the work of installing the heavy hoisting machinery is proceeding steadily. Men are now putting in the foundation forms for the hoist and working on the steel head-frame, which will soon replace the low wooden structure now in use. About 50 men are steadily employed.

The fine new electric hoist at the Plymouth mine has been in operation for a little over a week and is giving excellent satisfaction. This is the largest hoist in Amador county.

There appears to be some prospect of the early resumption of work at the old St. Jeanne mine near Jackson. A. Caminetti, Jr., has been on the ground during the week with James Ferrari estimating cost of machinery and supplies necessary for its re-opening; and it is also reported that T. M. Woode and J. S. Rear, Vancouver mining men, who are interested in Calaveras County mines, are considering the purchase of this old mine. The St. Jeanne is a pocket mine, one of which a number of years ago is said to have yielded \$75,000. This property, four miles south of Jackson, is on the "black metal" belt to the west of the Mother Lode, and samples recently taken show the slate in the formation to be full of gold-bearing sulphide. There is an adit 1000 ft. long in the ground.

Surveyors have been at work recently on the old Mitchell mine near Middle Bar, and it is also reported that the Mammoth tunnel, or Neville's mine will shortly be re-opened by a son of the elder Neville's former partner, Senator Jones.

As many men as can be worked to advantage are now engaged in unwatering and re-timbering the Hardenburg shaft near the Mokelumne river. This property was recently taken over by W. J. Lorine and others.

During the week, the sale of the briquetting plant of the Lignite Fuel Co. of Ione to C. A. Johnson has been concluded, for \$19,500. Borings and shafts show that nearly all of the valley between Ione and Carbondale is underlain by lignite strata, and with new capital for more extensive development, success seems certain for this industry.

Shaft-sinking and development are progressing most satisfactorily at the Amador Star, better known as the Rhetta

mine, four miles north of Plymouth, where Baylies C. Clark of Sutter Creek has a small crew employed. This mine was formerly worked by an adit, and when the new owners decided to sink a shaft 200 ft. south of the adit, they had to sink only 227 ft. to strike a body of ore 4 ft. wide, which assays well. Drilling is now in progress on this ore. The mine is electrically equipped and well situated for economical mining.

Work was commenced during the past week at the South Keystone property, near Amador City, and preparations are well under way for installing the machinery purchased on October 19 from W. J. McGee, assistant U. S. treasurer. McGee has sold to the new company the hoisting plant used a number of years ago at the Amador Queen property, two miles south of Jackson, and men are now engaged in preparing the engine, compressor, etc., for removal, while others are getting foundations ready for same at the North Star shaft of the South Keystone Consolidation. The group includes the McIntire, South Keystone, North Star, and Boyson claims, and lies near what is known as the "Amador Trail" between Sutter Creek and Amador City. Through the strenuous efforts of John A. McIntire, of Sacramento, negotiations were practically closed on this mining project last May, but unexpected delays occurred. Anton Huth, the Tacoma capitalist, with other Washington men was heavily interested in the project. Since his death in September, his interest has been taken over by his son, and a corporation was formed, capitalized at \$1,000,000, in shares of \$1 each, with the following officers and directors: W. Virges, president; C. H. Colpe, vice-president; Frank F. Wood, secretary and treasurer; John A. McIntire, director; and Carlton Huth, director. Colpe will act as general manager for the company, and he has employed J. Gallagher of Calaveras county as foreman. With the exception of John A. McIntire, all the directors are Tacoma men, although Wood has resided in San Francisco for the past two years. McIntire was the owner of the McIntire claim and also interested heavily in the South Keystone, and his faith in the property is shown by his retaining a substantial interest in the company as now incorporated. The first work contemplated is the unwatering and re-timbering of the North Star shaft, which has a depth of 1000 ft. From the 600-ft. level of this shaft, drifts will be driven to tap the orebodies in the South Keystone and adjoining claims. Indications are excellent for the development of large reserves of high-grade ore in this property in return for a comparatively small amount of work. Having as neighbors such well known old producers as the Keystone and the South Spring Hill mines, and having indications favorable for fully as good results as have been obtained at the other great mines of the county, this stretch of mining ground is locally held in high esteem and considerable interest is manifested in this new venture.

A heavy truck has been in use all the week hauling the machinery and entire surface equipment from the Amador Queen mine, south of Jackson, to the South Keystone mine, now about to be opened near Amador City. The hoist and other machinery will be put into service at once at the North Star shaft, from which the consolidated claims are to be developed. C. H. Colpe, the manager, is here assisting the foreman, J. Gallagher, who has a small force at work installing machinery. A drift will be run north from the North Star shaft into the South Keystone.

PROCEEDINGS of the Mine Inspectors' Institute of America covers 115 pages. The annual meeting was held at Joplin, Missouri, on June 13-15, 1916. Thomas Graham of Victoria, B. C., is president; the secretary is J. W. Paul of Pittsburg, Pa. Papers were read on gaseous coal mines, the lead-zinc mines of Joplin, mine inspection and safety first in California, permissible explosives, mine inspection in British Columbia, efficiency in mine inspection, and underground haulage. The next meeting is to be held at Indianapolis in July 1917.

SONORA. To work the old Confidence mine the Confidence Gold Mines Corporation has been formed with a capital of \$600,000. Past development is to a depth of 1110 feet.

YOU BET. Dredging is to be started by Los Angeles people at the Greenhorn at an early date.

COLORADO

On January 3, 4, and 5 the Colorado Metal Mining Association will hold its annual meeting at Denver. The proposed repeal of the present law for taxation of producing mines, proposed regulation of smelters by the Public Utilities Commission, tariff laws, and proposed new Federal mining law are subjects to be discussed. The tungsten miners are also preparing for the meeting.

BOULDER. To treat independent miners' ore the Degge-Clark company has erected a mill $5\frac{1}{2}$ miles from this centre. Low-grade tungsten ore is purchased.

BRECKENRIDGE. Profits of the Tonopah Placers Co. in the quarter ended August 31 amounted to \$54,780, against \$39,454 in the previous period.

CRIPPLE CREEK. Two carloads of ore from the Cresson mine sent to the Golden Cycle mill yielded \$200,000 net. This ore was from No. 15 level, where a large shoot has been opened for 150 ft. in height. Numerous vugs were found, some containing rich specimens of calaverite.

The first shipment of flotation concentrate from the Vindicator Consolidated's new mill has been made.

The Mary McKinney company paid 1c. per share last week. The shaft is now 1360 ft. deep. Prospects generally are good, although No. 11 level was disappointing. From January 1 to September 30, 1916, the revenue totaled \$193,859, of which

\$118,524 was from company and \$71,256 from lessees' ore. The profit was \$10,333. The cash balance is \$98,535.

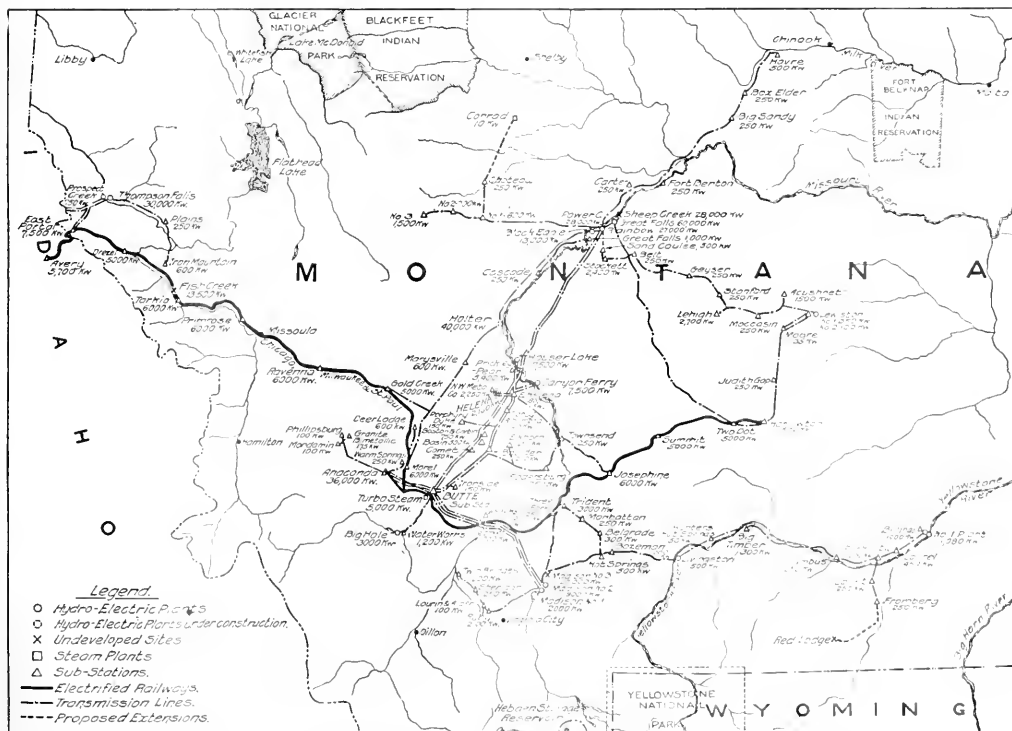
LEAVILLE. Three first-aid teams from the Yak Mining, Milling & Tunnel Co. competed for prizes on October 29. One team gave an exhibition of mine-rescue work on Labor Day, but the last results show great improvement. L. P. Shephard, safety engineer at the Arkansas Valley smelter, has returned from the fifth annual Safety Congress at Detroit, and considers that the safety-first movement is of far-reaching importance.

MONTANA

In the November issue of the *General Electric Review* most of the 130 pages are taken up by articles on electric traction, more especially with development in Montana. The use of hydro-electric power in that State is increasing rapidly, and besides being consumed by railways for ore transport and other purposes, the mining industry calls for large demands on the supply. The accompanying map shows the points of water-power development and consumption of electricity.

In the last number of the Montana Society of Engineers' quarterly journal, the present status of oil and gas prospecting in that State is discussed by D. C. Bard and Chester Steele. At present there are 12 drill-holes under way in various parts of the State. So far there is only one commercial oilfield, that near Elk Basin. Its capacity is 10,000 bbl. daily. Possibilities of finding more oil are considered good, judging by geological conditions. Gas has been found at three places, that at Havre being the best. The development of oil and gas for Montana industries is of immense importance.

BUTTE. With three shifts the Butte-Duluth plant is in operation after a year's idleness. During the testing period the



MAP OF MONTANA, SHOWING POWER-PLANTS, TRANSMISSION-LINES, RAILROADS, AND MINING CENTRES SUPPLIED BY ELECTRIC POWER.

rate of treatment is to be two tons daily. Resumption of work has stimulated the eastern part of the district.

According to H. N. Knowlton, of the Forest Products Engineering Department of the U. S. Forest Service, Butte mines are using 50% more timber than in 1911. The ratio of increase would not register the difference in mining operations accurately, as 1911 was a slack year for the mining industry of this centre, due to labor disturbances and other conditions, while 1916 is the most prosperous year in the history of Butte. The information is obtained mainly from the Anaconda, Butte & Superior, Elm Oribu, North Butte, East Butte, Davis-Daly, and a few smaller properties.

IDAHO

HAILEY. The Wilbert Gold Mining Co., operating in the Wood River district, distributes \$10,000 in dividends on November 15. This makes \$50,000 in about a year. The surplus is \$13,000. Thirty men are employed underground and in the mill.

KELLOGG. During September the Caledonia company's profit was \$100,000. On November 5 the regular monthly distribution of 3c. per share, equal to \$78,150, was paid. This makes a total of \$833,600 for the current year.

MILAN. At the American Commander claims the adit being driven has passed through several promising lead stringers.

NINE-MILE. At the Rex mine the Riblet aerial tram will be ready for carrying ore next week. Two crushers and a sorting-belt are being installed. Ore reserves are estimated at 12 to 18 months' supply for the 200-ton plant.

MICHIGAN

Houghton. At No. 1 re-grinding plant of the Calumet & Hecla, Chilean mills are to be replaced by Hardinge conical mills, one of the latter for two of the former.

MISSOURI

JOPPIN. All grades of zinc ore were stronger last week, the range being from \$67 to \$75.50 per ton. The output of the region was 9129 tons of blende, 2088 tons of calamine, and 1328 tons of lead, averaging \$68 \$19, and \$85 per ton respectively. The total value was \$833,613.

At a recent meeting of the Southwest Missouri Mine Safety and Sanitation Association, Walter Gregg gave a talk on efficiency in burning fuel, and on boiler arrangement.

The Continental Zinc Co.'s tract, operated by Frank Bryan, is producing 8 tons of first-class coal daily. The seam being mined is 4 ft. thick.

NEVADA

GOLDFIELD. Final figures of the Goldfield Consolidated for September show that 25,800 tons of ore gave a net realization of \$16,072. Costs totaled \$5.83 per ton, including 4c. for filter and 5c. for flotation royalties. Development covered 2255 ft., at a charge of \$6.83 per foot.

Good-grade ore has now been opened for a long distance in the Jumbo Junior, at a depth of 880 ft., which is regarded as of importance to this district. The Extension, Kowanas, Spearhead, and Mercer may benefit by the discovery.

PHOENIX. The new 300-ton rolling treatment plant at Pullmanville is a success, making a profit of \$5 per ton. The recovery of lead is 94%, gold 36%, and silver 30%. Weeds in the dump are troublesome, but when removed the precious metal extraction will be doubled.

ROCHESTER. The A. Leach & Sons Rope Co. of St. Louis is to construct a two-mile aerial tram to connect the Rochester Mines Co.'s mine and mill. The cost will be \$1,000,000, the work to be completed in 60 days. The cost of hauling ore will be between 6 and 9c. per ton, against 19c. at present via a haul-tramway.

(Special Correspondence.)—The Buckskin National Co. is

driving an adit to intersect the upper vein, which is 285 ft. west of the vein on which most of the work has been done, and prospects well near surface. The main orebody has been opened to a depth of 400 ft., and developed by 1300 ft. of laterals. Forrest Bell is superintendent.

The Hatch lease on Buckskin National ground is milling ore of good grade. The winze from the 300-ft. level has gained a depth of 25 ft., and at this point a cross-cut has cut the vein. Approximately 40 in. is worth \$50 per ton. A 2000-ft. adit has been started to cut the vein-system at a depth of 650 feet.

Wallace, a new camp about 10 miles south-west of Winnemucca, is claiming attention. On the Wallace & Kantenwein group two distinct veins have been uncovered, both containing gold and silver. A shaft is down 20 ft. on a 6-in. shoot of \$200 ore. Leases have been secured by Hermann & Truitt, Abel & Loinaz, E. D. Rogers, and several others. The place is five miles from Rose Creek station on the Southern Pacific.

Construction of the new aerial tram of the Rochester Mines Co., at Rochester, is proceeding. It will be over two miles long, and has a capacity of 500 tons per day. Improvements to the mill are going forward, and a Monarch furnace has been installed in the refining department. Inclement weather has somewhat hampered recent surface work. Underground operations are satisfactory, according to the report of the superintendent.

The west cross-cut from the 107-ft. level of the Nenzel Crown Point is out over 800 ft. and has cut eight shoots. A 5000-ft. three-inch pipeline is being constructed from South American canyon to furnish plenty of water. A late snow-storm delayed work several days.

Winnemucca, October 24.

NEW MEXICO

(Special Correspondence.)—The Socorro M. & M. Co. shipped 1800 lb. of gold-silver bullion from operations covering the first half of October.

Timbering of the new shaft below the 500-ft. level has been started at two different points by the Mogollon Mines Co. During the week 980 tons of ore was treated, and 1500 lb. gold-silver bullion smelted for the first half of the month.

The Oaks Company milled another lot of ore during the week, taken from development work on the Clifton mine.

A representative of the State Engineer's office has visited Mogollon, securing data and inspecting proposed hydro-electric sites. As all these power installations are under the jurisdiction of the State, this move is thought to augur favorably for an early realization of adequate and cheaper power for the district.

Mogollon, October 24.

OREGON

SUMMIT. The Taber Fraction and Rastus mining claims, comprising three acres of ground, have been sold to James A. Howard and associates of Baker, by the Taber Fraction Mines Co. for \$60,000, according to information received by A. G. Hammer of Spokane, who owned 70% of the shares. The Taber company's holdings are regarded as the richest for their size in Oregon, and in the 15 years they were operated before litigation caused suspension, about 8 years ago, they were credited with earnings of \$250,000. Work was resumed a few days ago through the workings of the E. & E. mine, adjoining, at a depth of 800 ft. vertical in Taber ground.

TEXAS

(Special Correspondence.)—The large deposit of celestite (strontium sulphate) three miles from Austin may be developed in the near future. It is owned by Judge R. C. Walker of this city. He proposes to install machinery.

Austin, October 26.

(S. P. Correspondence.)—The Texas Graphite Co. has made considerable progress in the enlargement of its mill, situated near ore. It has enough graphite developed to keep a mill of much

larger capacity than the present one in constant operation. Dan McFarland, manager, returned to the property recently from California.

Burnet, October 30.

(Special Correspondence.)—The mineral exhibit at the recent International Soil Products Exposition held here attracted much attention on the part of visitors. Collections of ore from many of the mines of the South-west and Mexico were on exhibition. One of the features of the mining department was a modern assay-office that was in actual operation by students of the Texas State School of Mines and Metallurgy. The equipment of the assay-office was of the most modern type, and was brought direct from the laboratories of the School. A large collection of ore samples, including many rare minerals, was also included in the School exhibit. F. H. Seamon, head of the chemistry department of the School, and H. D. Pallister of the geological department were in charge of the exhibit. Included in the mineral display that was made by Grant county, New Mexico, in charge of M. W. Porterfield of Silver City, were ore and water buckets of buffalo hides, used by the Spaniards in operating mines near Silver City in 1785. These ancient relics were discovered in the deepest workings of the mines of the Chino Copper Co. at Santa Rita. The buckets were used by the Spaniards when they worked the mines 131 years ago. The buckets are not of rawhide, as rawhide is known today. They are shrunken and of a greenish color from the copper ore. The hair is still on the hide. There was also shown in this exhibit a framework of timbers that was placed in the mine by the Spaniards and which is still in perfect condition. The timbers are less than four feet high, as the shafts driven by the Spaniards were only high enough to permit a man to crawl through them.

El Paso, October 30.

(Special Correspondence.)—Fire that considerably damaged the lower workings and mine equipment of the Chisos Mining Co. has delayed operations of this quicksilver property somewhat. Orders were immediately placed for new plant, which is expected to be installed in a short time. The furnace of the company was not damaged.

Terlingua, October 30.

UTAH

PARK CITY. Ten mines and lessees produced a total of 6311 tons of shipping ore and concentrate during October. The value was \$252,000. In September the quantity was 5345 tons.

TINTIC. Thirty-two companies and lessees produced 39,400 tons of ore and concentrate during October, valued at \$975,000. This was one of the heaviest months in the current year.

WASHINGTON

SPOKANE. The activities of the Anaconda Copper Mining Co. in the Coeur d'Alene district of Idaho, where it has a large zinc mine, have revived rumors that the company contemplates establishing electrolytic-zinc reduction works in or near Spokane, and it is said that representatives have been investigating the old smelter site three miles down the Spokane river with a view to purchase. Cornelius Kelly of Anaconda, vice-president of the company, with members of the metallurgical staff, were here several weeks ago investigating conditions, and they were here again recently checking their original preliminary survey of the situation.

The Loon Lake Copper Co., which owns and operates the Loon Lake property, 40 miles north of Spokane, in Stevens county, has authorized the expenditure of \$15,000 for further development, according to Frank G. Crane, secretary-treasurer, who states that the work will begin immediately. The mine is to be opened to 300 ft. greater depth, and levels will be opened each 100 ft. A 50-hp. boiler and engine, to operate the hoist and pumps, now are being installed together with a compressor and ventilating system. The lowest returns from shipments to the smelter were 11%, and the highest 13.75% copper.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

HOWARD D. SMITH is in New York.

E. M. ROGERS is here from New York.

L. D. RICKETTS was here last Saturday.

A. C. BEATTY is expected shortly in San Francisco.

F. F. SOSTWICK, of the Seoul Mining Co., is in New York.

F. L. SIZER, after a brief visit to San Francisco, has returned to Butte.

L. O. HOWARD is now in charge of the International smelter at Miami.

E. C. BLOOMFIELD has obtained a commission in the Canadian Engineers.

N. M. MUIR is superintendent of the Hanford mines at Jarbidge, Nevada.

JOHN BENDEL has been placed in charge of the power-plant at the Alaska Juneau.

ARTHUR K. ADAMS has gone to Chile as geologist to the Andes Copper Company.

H. L. CHRISTENSEN has been given general charge of mill-work at the Alaska Juneau.

H. H. COLLEY has been promoted to be superintendent of the Old Dominion mill and smelter, at Globe.

W. J. LAKELAND has resigned his position with the Burma Mines to join the Indian Army Reserve of Officers.

HENRY V. SNELL has been appointed superintendent and general manager for the Miami Consolidated Mines Co.

P. H. CRAWFORD left San Francisco for Nicaragua on November 4 to become superintendent of the Grecia mine.

W. W. WISNIOX has been appointed consulting engineer for the Big Casino Mining Co., operating near Searchlight, Nevada.

CHARLES BRUFF, of the firm of Bradley, Bruff & Labarthe, has left Juneau for Arizona, to assume charge of the construction of a large mill.

W. E. MITCHELL has gone from Anaconda to Great Falls to take charge of the Anaconda company's residue-treatment plant in the zinc department.

W. D. THORNTON succeeds THOMAS F. COLE as president of the Greene-Canaan Copper Co. It is understood that Mr. Cole is retiring gradually from active participation in mining affairs.

THOMAS RICKARD died on November 2 at Wimbledon, London, at the age of 85. He was the son of Capt. James Rickard, who came to California for John Taylor & Sons in 1850 to examine the Mariposa grant. As the senior member of the firm of Rickard Bros. he will be remembered by the older generation. A Cornishman by birth, a keen observer, a remarkable linguist, and an engineer of world-wide experience he played a leading part in the profession thirty years ago. Before practising as consulting engineer he was manager of important mining enterprises in Italy, Spain, Russia, and South Africa. The older engineers will recall his fine presence and courteous manner, as well as his wide fund of information. To them the news of his death will come like a regretful echo from days now far in the background of events. He was the last and the eldest of five brothers—William Henry, Richard, Reuben, and Alfred—all of whom played a notable part in mining, in our West as well as in other regions. He is survived by three sons, T. A., Forbes, and Herbert, and by three daughters, one of them the wife of F. W. Baker.

DAVID H. BIRDSALL, who for many years represented the Giant Powder Co. as salesman in the Pacific Coast States, died at his home in San Rafael, California, November 3, at the age of 84. He was known to nearly every miner in the country, and his many friends cannot fail to feel regret at knowledge of his death.

THE METAL MARKET

METAL PRICES

San Francisco, November 7.

Antimony, cents per pound	14.00
Electrolytic copper, cents per pound	29.25
Pig lead, cents per pound	7.25—8.50
Platinum, soft and hard metal, per ounce	100—106
Quicksilver, per flask of 75 lb.	\$80
Spelter, cents per pound	12
Tin, cents per pound	43
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, November 7.

Antimony, 50% metal, per unit	\$1.25
Chlorine, 4% and over, for cars California, per ton	15.00
Magnetite, crude, per ton	8.00
Manganese, 50% under 35% metal not desired	16.00
Tungsten, 60% W.O., per unit	17.00

New York, November 1.

Antimony: For high-class ore \$1.50 per unit has been paid, but only small quantities are available.

Molybdenum: Dealers report that the demand is steadily increasing, a part of it coming from new buyers. Contracts have been closed for all of 1917. Ferro-molybdenum has sold in the week at \$1 per lb. of molybdenum contained. The ore is nominally quoted at \$1.75 to \$1.85 per lb. for 50% molybdenum-content.

Tungsten: A good business is reported for October. Prices range for \$16 to \$17 per unit, according to quality. For some material \$15.50 has been taken. On the other hand, some interests ask \$18, but no business has been done at this figure. Practically all the tungsten ore on the here on future shipments has been sold. The foreign demand continues good.

EASTERN METAL MARKET

(By wire from New York.)

November 7. Copper is active, tending to become stronger; lead is firm, spelter is gathering strength, the demand being steady.

COPPER

Prices of electrolytic in New York, in cents per pound.

Prices of Specie				Average week ending			
Date	1914	1915	1916	1914	1915	1916	
Nov. 1	28.41	28.41	28.41	Sept. 26	28.41	28.41	
" 2	28.41	28.41	28.41	Oct. 3	28.56	28.56	
" 3	28.41	28.41	28.41	" 10	28.60	28.60	
" 4	28.41	28.41	28.41	" 17	28.50	28.50	
" 5	28.41	28.41	28.41	" 24	28.37	28.37	
" 6	28.41	28.41	28.41	" 31	28.50	28.50	
" 7	28.41	28.41	28.41	Nov. 7	28.79	28.79	
Monthly averages							
Jan. 1914	1915	1916	1914	1915	1916		
Jan. 1914	14.21	13.60	24.30	July	13.26	19.99	25.66
Feb. 1914	14.46	14.38	26.62	Aug.	13.34	17.27	27.93
Mch. 1914	14.41	14.80	26.65	Sept.	17.02	18.28	24.00
Apr. 1914	14.10	16.84	24.82	" 10	14.10	17.20	28.50
May 1914	13.97	18.71	29.02	Nov.	11.75	18.88	24.00
June 1914	13.60	19.75	27.17	Dec.	17.75	20.67	24.00

Eastern Metal Market

New York, November 1.

Domestic buyers of copper have been active in the past week, and the market is extremely strong.

Zinc is higher, with producers looking for a still stronger and sustained market. Dealers are buying at the present level.

Lead is fairly steady, but dull.

Large consumers of tin have been active buyers.

Antimony is dull again.

Aluminum is a little easier.

Excited efforts on the part of consumers of pig iron to cover their future requirements, together with the high price of coke, has caused the iron market to advance by leaps and bounds. Southern No. 2 iron is held at \$17, Birmingham. Virginia No. 2X is quoted at \$20, furnace, but the leading producers are out of the market. No. 2 Northern foundry is held at \$23 at Pennsylvania and Ohio furnaces, \$24 at Chicago, and \$25 at Buffalo. Steel-making irons are correspondingly high.

The steel mills continue to turn away export business. Prices announced by the Carnegie Steel Co. and the Illinois Steel Co. are 3.25c., Pittsburg, for plates; 2.80c., Pittsburg for shapes and 2.70c., Pittsburg for bars, deliveries at the convenience of the mills. Eastern Pennsylvania mills quote higher, asking at least 4c., Pittsburg, for plates, and 2.85c., Pittsburg, for structural shapes and bars. From all directions come complaints of the car shortage; meanwhile fuel costs are advancing. Prompt foundry coke is quoted up to \$8.50 per net ton at oven; prompt furnace, up to \$7.50. Next year's price for iron ore is expected to be \$1 per ton higher.

COPPER

New England brass-mill interests did some heavy buying of electrolytic on October 30 and 31, estimates placing the amount taken at 25,000,000 lb. The report referred to a week ago, to the effect that European interests were in the market for a large tonnage—said to be 1,000,000 lb.—is still existent, but no sale has been closed. Near-by metal is scarce, and none too much first quarter is available. It is predicted that if the demand continues, the end of the year will see first-quarter metal entirely absorbed. The brass mills have been buying to cover new contracts for their products, the demand for which seems to have no limit. While the recent buying has stiffened the market it has not caused any considerable advance in actual prices, and electrolytic is still 28.50 to 29c. per lb. for reasonably prompt delivery. December is quoted at 28.25 to 28.75c., and first quarter at 27.50 to 28c. Lake copper sold this week for prompt delivery at 29c. Near-by Lake is exceedingly scarce. Hot-rolled sheet copper is quoted at 37.50c., and cold rolled at 38.50c., delivery in the case of each to be at the convenience of the mill. Copper rods are 43c. per lb. and sheet brass 42 to 46c. These prices are mentioned merely to give an idea of the costs which manufacturers using such products must meet. The October exports totaled 29,180 tons. The spot quotation for electrolytic at London yesterday was £142 10s. against £144 a week previous.

ZINC

Quotations are on the upward trend, and representatives of the producers are frank in saying they expect to see them go higher. They expect high prices in the coming winter, and their view seems to be shared by dealers, for the latter have in recent days been placing contracts for future deliveries. Not only have the dealers been purchasing, but the brass mills have been active also, and under the combined influence of buying and a seeming unwillingness on the part of some producers to part with metal, prices have advanced. The spot quotation yesterday was 10.37½c., St. Louis, and 10.62½c., New

York. A slight cold snap last week is reported to have interfered with the operation of gas-fired furnaces in the West, and production was immediately affected. One result of the incident was to start speculation as to what will happen to these furnaces when real cold weather sets in. November delivery was quoted yesterday at 10.25c., St. Louis, December at 10.12½c., and first quarter at 10c. The spot quotation at London yesterday was £52 15s., against £54 a week ago. October exports totaled 12,180 tons. This is a great showing, but not a record-breaker. Of interest to consumers of zinc is the following announcement issued by L. Vogelstein & Co., New York:

"In view of the car shortage condition existing throughout this country and the movement on the part of the various railroad companies to increase the minimum carload lot from 50,000 to 60,000 lb. for spelter, and presumably for copper and lead, we will in future make sales in 30-ton lots instead of 25 as heretofore. However, we are perfectly willing to sell you 25-ton lots with the understanding that in the event of the railroads charging any additional freight on account of our shipping less than the minimum of 60,000 lb. you will assume this extra freight. We are advising you of this change at this time because the railroads have the right to ask the Interstate Commerce Commission for permission to publish the new minimum carload rate upon giving five days' notice, and it lies within the jurisdiction of that Commission to grant such request."

The base price of sheet zinc has been advanced to 16c. f.o.b. mills, carload lots, 8% off for cash.

LEAD

Throughout the week the market has been dull, but prices are fairly firm. The A. S. & R. Co. continues to quote 7c., New York, and 6.92½c., St. Louis. Independents in the past few days have been cutting the latter price in the West, while at Eastern points they are meeting the quotation of the big producer. Most of the recent business has been in the West. The situation is strong for the reason that near-by metal is not plentiful, consumption continuing to keep pace with production. Japan was a heavy buyer about ten days ago. The exports are large, those of October amounting to 4535 tons. The London market is unchanged at £30 10s.

TIN

Tin-plate mills, having fixed their 1917 base at \$5.75 to \$6 per box, and having booked heavy contracts for next year's delivery, have been active buyers of tin in the past week. On two or three days 400 or more tons have changed hands, mostly future deliveries. Despite the activity and the fact that licenses to ship from England are not so freely granted as they were a few months ago, the price has remained fairly steady. Spot Straits was quoted yesterday at 41.87½c. Spot Banca was quoted at 41.25c. As will be noted, the difference between Straits and Banca is much less than usually prevails. The large stock of spot Banca recently on the market has been pretty well cleaned-up, but more is expected to arrive this month. Total deliveries into consumption in October totaled 4556 tons, of which 556 tons came via Pacific ports. October arrivals totaled but 2655 tons. In stocks and landing at the end of the month was 3419 tons. The quantity now afloat is 2025 tons—regarded as small.

ANTIMONY

The market is extremely dull, and spot Chinese and Japanese can easily be had at 13 to 13.50c., duty paid.

ALUMINUM

For No. 1 virgin aluminum, 98 to 99% pure the quotation is 64 to 65c. per pound.

Mining Decisions

ABANDONMENT OF A MINERAL LEASE.

Under a mining lease made in 1862 operations were conducted until 1889 at which time the lessee paid up royalties due in full, dismantled its plant and ceased operations for 20 years, neglecting however to give notice of termination in writing as required by the lease. The lessors offered no objection and thereafter one of them took possession of the land and sold stone therefrom to a railroad company. On suit brought by executors 20 years later for minimum royalties it was held that acts of the parties constituted an abandonment and no recovery could be had.

Pursell v. Reading Iron Co. (Pennsylvania), 232 Federal, 891. June 7, 1916.

DESTRUCTION OF OIL WELL—MEASURE OF DAMAGE.

Where a party under contract to drill a prospect-hole conducted operations so negligently that three steel under-reamers were dropped into the well, and permanently destroyed the possibility of drilling it farther, in a suit brought against such contractor by the owner, the measure of damages would be the amount expended by the owner in bringing the well to the point where such destruction occurred, not the value of the well from the standpoint of oil produced if it had not reached its intended depth. If the injury were maliciously done the treble damage rule might be applied.

North Haddon Oil & Gas Co. v. Skelley (Oklahoma), 158 Pacific, 1189. June 13, 1916.

OIL AND GAS LEASE—MINIMUM RENTALS.

A sale of oil and gas underlying land with the right to remove the same for a year and as much longer as oil and gas was found thereunder, and providing for minimum rentals, was held to be a lease in effect if not in form, and assignees of the original lessee would be under obligation to pay the minimum rentals to the lessor during a period of one year from date of lease. The rule would have been different had the lease been construed as a deed and the rental clause as a mere covenant running with the land. In the latter event the lessor could merely have executed a forfeiture, and would have been unable to recover against the assignee through lack of privity of contract with the assignee.

Pierce Fordyce Oil Assn. v. Woodrum (Texas), 188 Southwestern, 215. June 3, 1916.

SEVERANCE OF MINERALS—ADVERSE POSSESSION.

The possession of the surface of land by one who has by his conveyance of the mineral interest severed the latter from the surface is not such a possession of the underlying severed mineral interest as will permit the surface owner's prescriptive title to inure to the benefit of his grantee. A surface owner not in possession cannot be executing and recording a deed purporting to convey the minerals, or sever them, or interfere with an adverse possession already begun on the whole tract. But a conveyance and surrender of possession of such minerals by the person in actual possession of the land would sever the possessory right to the surface and minerals, and also prescriptive right, commencing to run against him.

Northcut v. Church (Oklahoma), 158 Southwestern, 100. August 9, 1916.

EXTRAJURISDICTIONAL RIGHTS—PROPERTY—MINERALS—DEEDS.

Where a State statute gives title to the minerals on notice, but does not extend to the title to the surface, the claim is

a penalty for failure to record, the Federal courts will not declare a forfeiture in favor of those who had actual knowledge of the unrecorded location. A prior locator, who, in his application for patent excludes area in conflict with the claim of a subsequent locator, thereby creates a presumption against himself in respect to his right to the excluded area. Evidence held to show that the two veins in conflict crossed on the dip but did not unite. Where plaintiff has brought suit for the "value of ores wrongfully taken," it will not be permitted to claim "damages for the conversion of ores" as personal property, simply because the latter form of relief would enable plaintiff to take advantage of the enormous increase in the market price of metals. Value *in situ* awarded as damages, costs of mining and marketing being subtracted on the basis of what it would cost plaintiff to mine and market. Plaintiff's claim for value not saved in mill tailing disallowed, it appearing that such value exists solely by reason of the rise in metal prices since the trespass was committed.

Clark-Montana Realty Co. v. Butte & Superior Copper Co. (Montana), 233 Federal, 547. May 29, 1916.

Book Reviews

MINING WORLD INDEX OF CURRENT LITERATURE. Vol. IX. By Geo. E. Sisley. P. 297. Index. Mining World Co., Chicago. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.

This volume is a bibliography of the world's literature on mining, metallurgy, and kindred subjects that has appeared in periodical magazines, government publications at home and abroad, professional papers, and new books, for the first half of the year 1916. A brief digest is given of all articles, giving a general idea of the subject treated in each paper. Subjects and authors have been alphabetically indexed, making it easy to find information on any subject. The increasing importance of flotation is shown by the space devoted to that subject. Much care and considerable work has been expended by the author to facilitate ready reference to all subjects pertaining to the mining profession.

ANALYSIS OF COPPER, ITS ORES AND ALLOYS. By George L. Heath. P. 292. Ill. index. McGraw-Hill Book Co., New York, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$3.

In this treatise the author has gone most thoroughly into his subject and presents a book which cannot fail to be of interest and value to all chemists and others whose work includes the investigation of copper ore, the products of copper furnaces and of copper refineries. That portion of the book devoted to the equipment of modern metallurgical laboratories, including the electrical machinery and apparatus employed, is comprehensive and concise. A chapter on mine sampling in its various phases is excellent, and deals with the various methods employed, in which the author properly says the method adopted must be determined by the character of the ore. The part devoted to reagents and standard solutions is important and though not unlike similar information to be found in other works on the subject of metallurgical analysis, could not be omitted from this volume. The automatic sampling of ore at suchers and in custom sampling-works is described in clear language, and keeps this important branch of the business before the student and professional worker in convenient and compact form. Methods for the determination of the metal, as well as the unusual accompaniments of copper ore, will be found to cover the subject quite thoroughly, and the character of the various alloys of copper is indispensable.

Although there is already a rather voluminous literature on the metallurgy of copper ore and products, it will be found that this present contribution will not be unwelcome to those engaged in any branch of copper mining or metallurgy.

EDITORIAL

T. A. RICKARD, Editor

SPELTER is said to be sold forward as far as the second half of next year. About 30% of the probable output for the first half of 1917 is under contract. This compares with a forward selling of 80% of the copper production, but it should suffice to cheer the zinc miner.

OATMAN has organized a Bureau of Mines, and we wish it good luck. A little boosting is not a bad thing and the co-operative spirit is always commendable. We note that the campaign of publicity is to be conducted "along conservative and authentic lines." That is wise. We expect that the Bureau will serve also as a source of useful information to those interested in this promising mining district.

HARVARD offers a prize of \$200 for the best essay on plumbing. We hope that this signifies the belated recognition of the fact that even if plumbing be not a fine art it is an essential branch of modern engineering. Modern society made a great mistake in ranking the dentist below the physician, and it is paying for its snobbishness; likewise the civilized community makes a big blunder in ranking plumbing as less scientific than mosquito-baiting, in forgetfulness of the fact that sanitation, like charity, should begin at home.

EMPLOYMENT of Austrian prisoners is helping to compensate for the loss of native labor at the Siberian mines. Thus the place of the Russians called to the front is being taken by the prisoners that they send to the rear. The Germans are removed farther east and north than the mining regions that we have in mind, namely, the Altai, Akmolinsk, and the Ural. The Austrians are paid the standard local wages and enjoy freedom to the extent of not being under military restraint. American mining engineers report that the Russians are treating their prisoners, both Austrian and German, well. It is likely that many will settle in Siberia after the War.

NOW that the election is over we shall have a chance to get information that, except for the usual proportion of inaccuracy, is not vitiated by political prejudice. Of late we have been told on the one hand that our prosperity is due entirely to the sale of munitions and on the other hand that it is entirely independent of the conditions created by the War. The detached observer is aware that neither statement is wholly true, but that the truth inclines to the former. War business was the spring that set our national industries going at

an accelerated speed; every part of the country has responded to this stimulus until our railroad traffic exceeds the supply of cars, our bank clearings exceed in volume anything previously recorded, and our foreign trade is unprecedented. The only cloud on the horizon—apart from the great darkness across the Atlantic, of which we are ever sadly conscious—is the mania of speculation that has begun to engage public attention. There lies a grave danger, particularly in mining.

AMALGAMATING plates in stamp-mills absorb gold, as is well known. The copper under the silvered surface becomes enriched by subtraction of the gold in the amalgam that in turn arrests the gold in the pulp that passes over the plates. We note that the September reports of the Alaska Mexican and Alaska Treadwell companies give the net yield obtained from the 'sweating' of the old plates in these two mills as \$26,035 and \$42,289 respectively, making \$68,324—a not inconsiderable sum. It would be interesting to ascertain the time and tonnage involved in this absorption. At the Yellow Aster mine, Kern county, California, when about 650,000 tons of ore had passed over the mill-plates, yielding approximately \$6,500,000—about \$10 per ton—the plates were 'sweated' and thoroughly cleaned, the result being a recovery of nearly \$125,000 or about 19 cents per ton of ore.

PROVIDENCE appears to favor the United States. Although we would have liked to see Mr. Hughes President, chiefly because of Mr. Wilson's lack of policy in Mexican affairs, we recognize that a change of Chief Executive during a time of crisis is dangerous and for that reason it may prove best that the President was re-elected. If now Mr. Wilson will re-organize the Cabinet, replacing one or two notoriously weak heads of department, and if he will adopt a clear policy toward Mexico, we shall feel as cheerful as the high cost of paper and potatoes will permit. Indeed, the report comes from Washington that he intends to take vigorous action. It is said that the President has undertaken to tackle the Mexican business and do something definite to restore order in that distressful country. We know that our clientele will be devoutly thankful if he does so. To the mining profession the closing of Mexico is a calamity.

COPPER production threatens to be much over-done before the War is over because the expansion is based on temporary requirements. It is reported that the existing plants for refining, having a capacity of 150 million pounds monthly, are to be enlarged to a capacity

of at least 240 million pounds, with still further additions in prospect. That indicates a production of 1,500,000 tons of refined copper by the end of 1917 or about 30% more than the whole world's production in the year preceding the War. The capacity of the principal refineries and the enlargements said to be planned are outlined as follows:

	Tons of copper per annum	
	Present	Prospective
A. S. & R.	456,000	690,000
Anaconda	330,000	360,000
Nichols	210,000	240,000
U. S. Smelting	102,000	120,000

FIRST PLACE in our 'Discussion' department this week is given to Mr. A. Stanley Elmore's reply to the comments made by us on his statement appearing in our issue of September 23. We thank Mr. Elmore for his courteous and interesting response. As to the relative knowledge of flotation obtaining on the two sides of the Atlantic, it is hardly worth while to dispute. The tonnage now being treated by the process in the United States ought to give, if it has not already given, our engineers an intimate and up-to-date acquaintance with the technology of flotation. At least we can say that more has been published on the technology of the subject in this country during the last two years than was given to the public in ten years previously by the practitioners across the water. We would like to know more about the use—"years ago"—of coal-tar and similar by-products instead of oil. If this included soluble frothing agents, as is likely, it is an important fact. Mr. Elmore scores a point in proving that Robson avoided the use of an excess of water. In regard to the statement that Mr. Frank Elmore obtained a suggestion from the remains of Robson's experimental material at the Glasdir mine, we accept Mr. Stanley Elmore's denial, but he places too much emphasis on the Robson & Crowder "machine." The supposition was not that any machine was used, but only test tubes and other simple laboratory apparatus, together with oil and pulp left behind, in such a way as to be suggestive of the kind of work that had been done by Robson. It would be worth while for Mr. Frank Elmore himself to publish an explicit denial and so kill the story conclusively. As to the air, Mr. Elmore ignores the discussion on Mr. Rolker's paper before the Institution of Mining and Metallurgy in 1900. The knowledge of the important part played by air came soon afterward we are ready to believe, but it was absent at the time when Messrs. Elmore, Rolker, Bayan, and McDermott discussed the Glasdir bulk oil operations before the Institution. Mr. Elmore's statement that air is "not essential to the selective action of oil in a large quantity of water" is most interesting and we direct the attention of other investigators to this assertion. The hint that the "man contest" is to arise over issues not involved in the Miami suit is highly important. We share the opinion that the Elmore vacuum patents will prove an obstacle to the monopoly of flotation by Minerals Separation. That issue has yet to be tried.

ABANDONMENT of the gold standard in Europe, or a suspension of specie payment, has been made the subject of a questionnaire by *The Analyst*. It is interesting to note that out of 92 prominent economists 82 voted that the gold standard would be maintained after the War and only 7 voted to the contrary. Mr. Adolf C. Miller of the Federal Reserve Board, and formerly Professor of Economics in the University of California, believes that the gold standard will survive, despite the fact that all the belligerent countries except England have long since suspended specie payment, and even in England it is not patriotic to ask for gold at the bank. Neither England nor Germany can hope to recover her foreign trade without a sound system of banking and finance. The German mark must be brought back to a parity with gold and the British pound sterling must recover its high prestige. No effort therefore will be spared to build up the gold supplies "so as to bring them more nearly into equilibrium with their credit currency," as Mr. Miller says. Meanwhile the world's entire supply of gold (not including jewelry or works of art) is estimated at about eight billion dollars, or as much as would make only a 60-ft. cube of metal. On that the super-structure of the world's credit is imposed. Mr. Theodore H. Price estimates that the United States holds 2½ billions of the gold of the world, or nearly as much as all the Allies, among whom Great Britain holds about one billion of gold. Germany is credited with \$600,000,000. The debts of the belligerent nations amount to 66 billions, of which 44 are debited to the Allies. The balance of trade in favor of the United States will be 2½ billions during the current year, and if the War lasts through 1917 and the balance of trade is as great as in 1916, the United States may find herself in possession of half the world's gold supply. Meanwhile Great Britain controls two-thirds of the world's gold production and there remains the possibility of so taxing jewelry and works of art as to bring a big stock of gold into the melting-pot. These last two factors have been overlooked in recent discussions. The world produces about \$460,000,000 in gold annually, of which \$300,000,000 is produced in the British dominions. The amount of gold consumed in the arts has been variously estimated; it is equal to about one half that used for monetary purposes. The moral is that we should bestir ourselves to stimulate gold mining in this country.

The Holmes Memorial

In a recent issue we referred to an association formed at Washington to perpetuate the memory and good work of Joseph A. Holmes. During the past week Dr. David T. Day, the honorary secretary of the Association, has been in San Francisco and has taken steps to arouse the interest of the mining profession in the plan to memorialize the first Director of the U. S. Bureau of Mines. Our readers will sympathize with any effort to do honor to Holmes as they were always glad to support him when alive, yet we venture to say that the most fitting

memorial to him is the complete success of the Bureau of Mines, which he organized and directed in its beginning; and if that be not enough, there is also the fact that among those now prominent in asking the public to honor him are several that tried to prevent the formation of the Bureau and the subsequent appointment of Holmes to the directorship. We say this in no mean spirit, but in justice to the memory of a good citizen. 'Safety first' was the slogan of Holmes; it has given an impulse to a great variety of systematic effort designed to decrease the risk incurred in the work of mining. It is proposed now to do something further in this direction in order to honor Holmes. The distribution of medals has been suggested as a method for recognizing the observance of safety principles. Arrangements for talks on the subject to the mine-workers might be another effective way of encouraging interest in the matter. Unfortunately, from the 'safety' point of view, the miner is essentially a venturesome man; his choice of an occupation indicates the willingness to take chances—therefore it has proved difficult to eradicate carelessness. Men will persist in entering a powder-magazine while smoking a pipe; they will insist in lowering men in a cage with the brake only; they will work under bad ground. The temperament of those that go down the mine in skips and follow a dangerous occupation amid the darkness underground will have to be changed before we make them murmur to themselves 'safety first.' One way to do it is to get some of the more thoughtful among them to give talks on the subject to their fellows: a kind of lecture from a working-man to his mates. Some of the older and better educated might be selected by the Holmes Association and paid reasonably for their work as exponents of the safety idea. We suggest this as one method of honoring the founder of the Bureau of Mines. The local branches of the mining engineering societies will be asked to give their support.

Pan-Americanism—A Myth

In the latest issue of *The Annalist*, Mr. H. J. Davenport, Professor of Economics in Cornell University, argues that there is no hope for the appreciable extension of American trade into South American markets. This opinion runs directly counter to the vigorous propaganda of the National City Bank of New York, which has been doing earnest work in a systematic effort to awaken American interest in South American trade. Professor Davenport asserts that any ground gained during the War cannot be held permanently; the reason why formerly we have not sold our products in South America being exactly the reason why in the future we shall fail to do so: we do not produce the things that the South Americans want and we do not want the things they produce. On the other hand, the South Americans do produce what Europe wants and Europe can supply them with what is wanted in South America. The things that we want to buy, Europe, not South America, is

willing to sell; what we want to sell, Europe, not South America, is able to buy. The exports of South America, like our own exports, rightly go across the Atlantic to Europe. Therefore, South America is our competitor, not our customer.

So little in the way of enlightened effort has been done to develop those new avenues of trade which the United States must find if she is to hold her present status as a creditor country that we are loth to depreciate or deprecate the work done by the National City Bank and their friends. Yet we had come to the same conclusion as Professor Davenport before we had read his article. In trying to develop trade with the countries of South America we are 'barking up the wrong tree.' We have been led by the lure of Pan-Americanism, which, like the Monroe doctrine, is a devitalized formula. The term 'Pan-Americanism' has bemused us; we have been attracted by the word 'American,' just as we were fascinated by the word 'republic' when used to designate the military autoeracies to the south of us. We have been hypnotized by a fallacy and misled by a phonograph—Mr. John Barrett.

A few days ago we listened to a paper on this subject by Mr. Lincoln Hutchinson, Professor of Commerce in the Department of Economics of the University of California. It is gratifying to know that there is a chair of Commerce in our State university and that the geographic phase of commercial activity is being elucidated for the benefit of our young men. Professor Hutchinson has returned recently from a journey of observation in South America and speaks with first-hand knowledge. He is entirely in agreement with the gentleman at Cornell, and what is equally important, with the more thoughtful and frank among South American observers. Turning to simple matters of geography, Professor Hutchinson suggests that most of our people are unaware of the fact that the whole of South America is nearer to Europe than it is to the United States. Even with the advantage of the Panama Canal, two-thirds of the area and two-thirds of the people of South America lie nearer to Europe than to us. The A. B. C. countries—Argentina, Brazil, and Chile—to which we have turned for advice on the Mexican muddle, are among the farthest from us and from Mexico. We hear occasionally of the "vast populations" of South America, but the whole area has only 70,000,000 inhabitants, while Europe, which is nearer, has six times the number of people, and the eastern part of Asia, which is no farther from us, has a population nearly ten times as great as the whole of South America. Of our trade, 50% of the imports comes from Europe and 61% of the exports goes thither, in normal times. With England, Germany, and France we do 35% of our import trade and 48% of our export trade. Only 12% of our foreign purchases come from South America and only 5% of our exports are sent thither. The sentimental notion that we are racially akin to the people south of us is a pathetic fallacy. By the last census the population of the United States was shown to be 89%

'white,' or of European origin. In so-called Latin America only two countries, Argentina and Uruguay, show any similar proportion. In Chile the whites and creoles represent 30 to 40% of the inhabitants. In all the others the Indians, negroes, and half-breeds predominate. Bolivia has only 13% 'white' population; Brazil and Peru, each 14%; Ecuador, Colombia, and Venezuela, 1 to 2%. In all of these countries the 'white' blood has been drawn from Southern Europe and not from the countries that gave us the citizens who have played the chief part in the development of our institutions and the exploration of our resources. In no South American country do our own people constitute even a significant fraction of the population. In every one of the South American countries the prevailing religion is Roman Catholic. Whether that be an advantage or a disadvantage does not arise in this argument, which has been started to prove unlikeliness between the United States and South America. Nominally the Pan-American countries are 'republics.' In theory, that is so; in practice, the reins of government are in the hands of a dictator or of a coterie of politicians, usually sustained by force of arms. 'Popular government' and 'democratic principles' are empty phrases as applied to South America, and every intelligent student knows it. Their legal system is based on the Civil Law; ours is based on the Common Law; and the divergence between the two is not easy to reconcile. The social customs of the two geographic divisions are sufficiently different to be a hindrance to a mutual good understanding. Concerning customs, as concerning humor, it is unwise to dispute. Whether administrative methods are more corrupt there than here, we do not undertake to say, but we emphasize the fact that the methods differ to the point of incompatibility. As to education, 24% of the population of the United States attends school; the highest percentage of schooling in South America is 11 in Uruguay and the lowest is 1% in Venezuela. In Chile the percentage is 9; in Argentina, 7.1; in Brazil, 3; in Bolivia, 2 only.

All of these facts are recited not in any spirit of antagonism but simply to bring home the truth that Pan-Americanism is a figure of speech, a snare and a delusion to anybody wishing to see things straight. The United States has, we believe, so many—i. e., geographic, racial, political, legal, social, educational, and commercial with Europe, particularly Western Europe, especially with England and Germany—that this attempt to steer us from our natural course should be opposed frankly and vigorously. As Professor Hutchinson has said: "We are turning from our real associates in the international world, those that have done things in the cause of free and enlightened institutions, we are assuming naively that somehow we of America, North and South, are better than those of Europe, we are playing at international politics with the kindergarten people to the south of us like a Peter Pan among the nations who has declined to grow up, we have even thought so little of the sanctity of our political ideals as to ask six of these countries to help us make up our minds as to what

our duty is in an important international question in which they have no interest whatever and in which Europe has interests second only to our own." To this we may append an expression of opinion by a distinguished Brazilian, Dr. Oliveira Lima. Writing in the *Revista do Brazil* recently, he said: "Pan-Americanism, to us, seems mockery, and impossible of realization. There is no racial, linguistic, traditional, or religious community between Anglo-Saxon America and Latin America. The geographic situation has no significance when one considers the distances separating North America from South America. * * * True, we have some interests and sentiments in common, which, properly agitated and played upon, may bring excellent results. 'Pan-Americanism' continues to represent the ideal of a single union, and, like other 'isms, is continually exhibited for the 'grand effect' on the people, but its actual influence is somewhat less than that of a substantial, solid, silver dollar." We are misled by 'isms into giving aid to 'istas, in Mexico.

Commerce finds the cheapest market as surely as water runs down-hill. Our trade before the War was mainly with Europe; and with Europe we shall have to trade, if we desire to trade profitably, when the War is over. Instead of harboring illusions concerning the possibilities of developing a big business in South America, we ought to send a commission of experts to Europe to ascertain the kinds of commodities that will be in greatest demand when peace is restored, and we ought also to give thought to creating a shipping that will carry our products overseas, instead of depending for transport upon foreign ships. During the last two years several economists and statesmen have adverted to the fact that American trade floats on British bottoms no less than the Monroe doctrine floats on the British navy, and has done so ever since Canning suggested that policy to Monroe in 1823, as a defensive measure against the Holy Alliance. With the War has come a great increase of financial responsibility and luckily we had the Federal Reserve system of banks to meet the contingency, but with Peace will come fresh duties, national and international. Is the United States to be another Korea, a hermit kingdom, that avoids dealings abroad and refuses to protect its citizens when they go away from home in quest of business or speculation? If we are to play a manly part in the comity of nations we shall want a shipping of our own to bear our products overseas and a navy adequate to guard our mercantile marine as well as our shores in the days of larger international life that loom ahead. To get the right aspect, let us rid ourselves of the hypnotic influence of mere names; let us aim to deal with people that have something to exchange, realizing that business is not built on shibboleths but on mutual necessities and the goodwill that follows the adjustment of them. Let us face east, not south, for there are the countries of our earliest origin and the markets by which our trade has been developed; there lies the past of our history and the future of our commerce.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Elmore and Flotation

The Editor:

Sir—I have just received a copy of your issue of September 23, and have read with great interest the editorial article on my notes which you have favored me by publishing.

I am under obligation to you for your sympathetic appreciation of the work of my brother and myself, and in so far as your comments are a criticism or express doubts, I recognize their friendly tone, the independent fair-mindedness, and the desire to get at the truth which prompted them. I also avail myself of this opportunity of thanking the large number of engineers who have written me; all expressing gratifying concurrence in the views expressed in my notes, and conveying their congratulations on the clear statement of the case presented.

As, in addition to answering the specific questions you put to me, I wish to make a few observations on some of your editorial comments, perhaps it will be more convenient if I take them seriatim.

You say "the flotation vendetta is better understood in London than the technology of the process." You are probably right as to the first part of this statement, but I cannot accept the latter part of it. I do not, of course, deny—it would be ridiculous to do so—the great application of the flotation process in the United States (although rather late in the day), the large amount of excellent scientific and practical work which has already been accomplished by American engineers, and the great experience they have gained. But I do say that had the work of English engineers having special experience in this branch of metallurgy been more fully drawn upon, the industry in America might have been saved a vast amount of time and money. This I am convinced of, as a result of the perusal of patent specifications filed and literature published of recent years, and of personal contact with a number of American engineers.

Almost every day I read or hear of some supposed new invention or development in connection with flotation which is announced with all the pomp and circumstance of a great discovery, but which, in fact, is "old as the hills" and quite often found to be described in some of our earlier patents or documents; to have been thoroughly tried in our testing works; proved useless for practical purposes and abandoned, or on the other hand considered part of our original invention and given to the world without rushing off to the Patent-Office to

seek further protection. Two instances come to mind as I write: first, I am told that someone has discovered that coal-tar can be used in place of oil and that this discovery constitutes a great advance. Years ago we used, for the same purpose, coal-tar, wood-tar, tar from blast-furnaces, and tar from the scrubbers of suction-gas engines. This information was spread broadcast from our testing works and was published (without being claimed) in some of our earlier patent specifications. Second, there is the case of the supposed recent discovery that gold ores can be successfully treated by the flotation process. In the year 1902 a working Elmore plant was erected on a gold mine in Australia; subsequent to that date Wernher, Beit & Co., by their engineers, made a careful investigation on a working scale of the Elmore process to ascertain its applicability to the gold ores of the Rand; furthermore, working plants were erected on five different gold mines in various parts of the world. In some cases the process was used in conjunction with cyanidation.

I now turn to the story of the virgins, quoted from Herodotus 194 in Melpomene IV. If this is, as you say, apocryphal it only emphasizes my protest against its being introduced, as it was in fact, to the attention of the Courts.

I see that you regard as new my "argument" that Robson & Crowder "avoided the use of an excess of water." As I attach much importance to this, may I say that it is not simply an "argument" but a *fact* stated in their own specifications as the following extract from British patent No. 427 of 1894 (lines 15 to 19, page 4) granted to Robson & Crowder proves:

"* * * according to this invention we effect the separation of the metallic matter by the mixture of oils alone, using such mixture to wash out the metallic matter and avoiding as far as possible the presence of water in excess of the quantity hereinbefore mentioned, as we find an excess of water prevents the successful carrying out of the invention."

To find out what "the quantity hereinbefore mentioned" is, one must refer back to line 43 on page 2 of the specification, which says:

"Thus the said substances" (crushed ore, tailings, etc.) in a *moist state*, that is to say, containing 25 to 30% of water—are to be mixed with the mixture of oils so that the metallic matter shall be removed from the "mud or mass."

That is clear enough, and further confirmation is found in Robson & Crowder's British patent No. 2538 of 1895, wherein they state that it has been discovered since

the date of their patent of the year before, that in some cases the moistening with water is fatal to good work and (at line 21 of page 2):

"It is necessary to first moisten the metalliferous substances with a liquid other than water, as, owing to some peculiar nature of the said substances (crushed ore, etc.), the water, if added first, prevents the fatty oil or matter from acting in the desired manner."

All through these two specifications it is impressed on the reader that the condition of the material operated upon must be "moist or plastic," "moist or pasty," "in a plastic condition," "a plastic mass," and that very little, if any, water is to be used.

I say that that is the absolute antithesis of what Frank Elmore did, or what he taught, and of what everyone since the publication of his work has done.

Frank Elmore's discovery was the "freely flowing pulp," the "perfectly mobile medium," into which to introduce the oil; the "crushed ore freely suspended in a large quantity of water"; the "oiling in diffuse suspension of the metallic as distinguished from the rocky particles," and all this was clearly stated in the claims of his British and German patents quoted in my previous communication.

Now to turn to your statement that I have not explained "that the plant in which his (Frank Elmore's) first experiments were made was the one at the Glasdir mine in which Robson had made his ineffective attempt." You ask me to "clear this part of the history" because you "have been informed on good authority that Mr. Frank Elmore found the remains of Robson's experimentation in the form of oil, pulp, and apparatus, at the Glasdir mine, when he himself first arrived there." On the assumption that your "authority" is as accurate as he is "good," you hint at the natural suggestion that these circumstances led Frank Elmore to experiment with Robson's apparatus. I have repeated what you have said so that there may be no misunderstanding as to what I am replying to, and so that the question and answer may be before the reader at the same time.

My reply to the above is that there is not a word of truth in it, not a shadow of justification for any one of the suggestions or innuendoes or whatever they may be. It is absolutely untrue to say that Frank Elmore ever experimented with the small Robson & Crowder machine which at one time was at the Glasdir mine (the mine referred to in my previous article); it is untrue to say that that machine was at the mine when Frank Elmore first arrived there, or that there was any of the pulp, oil, or apparatus of Robson and Crowder there. When Frank Elmore first arrived on the mine not a vestige of any of these things was present. Even the tumbledown shed in which the Robson & Crowder experiments had been made had disappeared and had long previously been replaced by a large mill containing jigs, shaking tables, crushing and classifying machinery upon the tailfines from which Frank Elmore first experimented in new apparatus constructed entirely by ourselves and at our own cost.

I am speaking from memory, but am sure I am within

the mark when I say that it was at least 12 months (and I have practically no hesitation in saying two years) after the erection of this jig-mill, and the consequent disappearance of the Robson & Crowder apparatus, that Frank Elmore first came on the property to experiment. As a matter of fact, *Frank Elmore has not at any time even seen a Robson & Crowder machine.*

Many insidious statements, with as little foundation of truth as the above, have from time to time been assiduously circulated in the hope that they would get in their deadly work before I had a chance of "nailing them to the counter," and I thank you for having drawn my attention to this one, which is new to me.

You may be interested to know that I have, somewhere among my papers, a letter from Crowder in which he congratulates us upon the success we have made where he and Robson had only encountered failure; and in which he compliments us on having discovered the one thing essential to success which had always eluded them.

I now come to your statement that "in his (Frank Elmore's) first invention he missed the third essential, one as important as the water and possibly more important than the oil—namely, air." Permit me to say you have quite overlooked the reference in my article to the important part played by air, as you will see on reference to the second paragraph of the second column on page 452 in your issue of September 23. We were quite cognizant of the fact that it was the air entrapped in the bulk of oil which rendered it capable of carrying more than its theoretical load of concentrates, even in the "bulk-oil" modification of our process.

In Frank Elmore's first patent specification the fact that the oil is impregnated with air-bubbles is stated in specific terms. I could multiply instances showing where in the very early days recognition of the effect of air or gas was quite obvious, but perhaps one more reference will be sufficient; it is to be found in a report addressed to John Ballot by Sulman & Picard, who at the time (May 1902) were engaged at the Elmore works supervising tests on gold ore from the Lake View mine. In that report the fact that the oil is "honeycombed by air" is noted. But long before that date, from the date of the earlier trials of the Elmore plant at the Glasdir mine, air was deliberately introduced for the purpose of buoying up individual greased particles of mineral and groups of greased particles, forming nothing more nor less than a "froth." This early knowledge of the effect of air was applied in two different ways, was in constant use, and was inspected in operation by a large number of engineers who visited the plant from time to time.

In the working of the Elmore plant it was found that depending upon the kind and quantity of oil used and upon other conditions there was a greater or smaller quantity of greased mineral particles which had not been collected in the bulk of the oil used, some of which were floating, some sunken, and others in an indeterminate state—suspended in the tailing-water.

With the object of recovering these greased particles, the tailing pulp was caused to travel down long launders

and over a fan-shaped distributor discharging into a spitzkasten, which resulted in the mixing of air with the pulp and caused the greased particles to float. The spitzkasten was fitted with a skimming device which removed the floating 'scum' or 'froth,' or whatever you like to call it, from the water-surface of the spitzkasten. This gave such satisfactory results that it was thought advisable to try to carry the flotation effect of air still further. So, to obtain the admixture of a greater quantity of air and secure a more certain contact of air with the greased mineral, the outlet from the spitzkasten above referred to was run into another spitzkasten where the pulp was violently agitated by fine jets of compressed air blown into the bottom of the pointed tank and the floating froth of greased mineral and air removed from the surface.

While I trust this statement will remove any doubt existing in your mind on this subject, I would like to point out as a matter that may interest other investigators that the presence of air is *not* essential to the operation of the selective action of oil in a large quantity of water. Mineral may be selectively coated with oil in the entire absence of air and this fact may give food for thought to some of those gentlemen who are rather hasty in rushing into print with theories.

With regard to the statement by Walter McDermott in his article in the *Engineering & Mining Journal* of February 14, 1903, that "the agitation with the pulp results in the oil taking up an appreciable quantity of air," I would say, with his approval, that he was not claiming then to make any new statement; he was merely stating what he knew as a result of his intimate knowledge of the regular working of the Elmore process; knowledge common to the large number of engineers who, prior to that date, had had opportunities of studying the plant in operation.

As I have shown above, we were well acquainted with the action of air in these processes right away back to the earliest days.

As I have already written more than I had intended, I do not propose to go into the question of how much or how little Froment's work aided in the development of the industry. Much of an illuminating character could be written on this point, but in the meantime I will content myself by repeating that although Froment's patent was set up as anticipation of Elmore's vacuum patent, this case was not proceeded with, and a clear defence is furnished by Stanley Elmore's 'acidulation patent' and by prior public use, as explained in my article.

As to that "keen sense of betrayal" which you think my previous article shows, and as to the resignation of my brother and myself from the Institution of Mining and Metallurgy, I would prefer to say nothing at all, as to do so would be to invite discussion along purely personal and sentimental lines, leading to no useful end.

It remains to be seen if you are correct in your statement that "the main contest over the patents is now in progress in the United States, as our readers are aware, by means of the suits brought by Minerals Separation

against James M. Hyde and the Miami Copper company respectively." Personally I do not think you are right, for I believe the "main contest" has yet to be started.

A. STANLEY ELMORE.

London, October 21.

Local Stories About Mines

The Editor:

Sir—I recall a condition at a well-known Western mine a few years ago that not only emphasizes the importance of accurate maps and records of mine-openings but tends to prove that "men willingly believe what they wish."

The mine was equipped with a drainage adit at the 1200-ft. level, and levels at 1400, 1500, and 1600 ft. The last connected, through a short raise, with a drift of an adjoining mine that served, at one time, as a means of drainage below the tunnel; but because differences arose between the respective managements, a concrete bulkhead prevented proper drainage. Except during the summer thaws when the 1500-ft. level was also flooded, the water-level in the shaft stood between the 1500 and 1600-ft. levels, the head being sufficient, apparently, to force the water through the fissure into the neighboring mine. This condition had existed about ten years.

The pressing need was for more ore. The only map of the flooded workings was an inaccurate tracing. Persistent reports were heard from offices of the company, and others, of high-grade ore on the 1600-ft. level that, it was said, was similar to ore being mined from the same vein above the 1200-ft. level. It was stated that shortly after ore was discovered on the 1600-ft. level, water broke into the drift in such volume that the miners had time only to save themselves, and that tools, machines, cars, etc., were abandoned. The water story was plausible. It was said that the local post-master, an old-time miner, was driving the drift when ore was disclosed; he was visited and questioned; he seemed reliable and to remember details clearly, the position of the ore, its appearance and approximate thickness, the inrush of water and two cars of first-class ore left on the station. The mill-superintendent, a resident of over thirty years, and a man of unquestioned veracity, stated he did not see the ore, but its existence and the miners' hasty exit were well-known facts. The various reports agreed fairly well.

It was determined to unwater the shaft, which, considering means at hand, seemed difficult; however, it was accomplished in due time and when the water-level finally stood below the 1600, the superintendent, eager to see the ore, waded with hip-boots through two or three feet of accumulated slime for several hundred feet to the breast, only to be disappointed. It was a fairy-tale. After cleaning out the 'muck,' not only was there no ore, but no tool, no piece of a machine, no car could be found on the level.

Later, a prominent man, at one time manager of the

mine, told the company's president that the ore was in a cross-cut south of the shaft, or on the side opposite to the main vein, and 35 ft. below the 1600 station. This was given little credence because knowledge of the geology indicated this cross-cut to be in foot-wall quartzite and to cut no veins of size. Nevertheless the 50 ft. of dump was cleared of years of accumulated debris, only to find the cross-cut barren.

The mill-superintendent was incredulous and had to be taken underground to be 'shown.'

RUSSELL T. MASON.

Los Angeles, October 6.

Porphyry Copper

The Editor:

Sir—The interest of many mining engineers, geologists, and others is now centred in copper. This fact induces me to suggest that the present is an opportune time to correct an error in our copper nomenclature. I refer to the use of the word 'porphyry' as applied to certain deposits of disseminated copper ore occurring usually in masses of igneous rock.

The word 'porphyry' has a particular place in our scientific language. It has been used in a definite sense for many years to designate the texture of certain igneous rocks in which megaseopic crystals or grains of one mineral occur scattered through a groundmass of the same or other minerals. The appearance of such ores being similar to that of true porphyritic rock many writers adopted the expedient of using the term to define the ores. In the beginning it was used apologetically and with quotation marks. Later the quotation marks were dropped and the ores referred to as the "so-called porphyry coppers."

If these ores were always mentioned as being of porphyritic texture there would be less objection to the use of the adopted term, but since other types of copper ore are found in many districts associated with porphyritic rocks a certain amount of confusion frequently results. I have been particularly impressed with the necessity of having a better definitive for these ores since reading the paper on the geology of the Warren mining district presented by Messrs. Bonillas, Tenney, and Fauchere at the recent meeting of the A. I. M. E. and published in the September bulletin of the Institute. The authors of this splendid paper discuss several types of ore that occur in the district, among them those which are found in a porphyritic igneous rock and to which they refer as "porphyry ores;" also those which are found disseminated in limestone and which they call ores of "porphyritic texture." A careful distinction between noun and adjective and a judicious use of quotation marks has enabled them to convey definite ideas. In a less carefully written paper confusion of ideas would certainly have resulted. Readers of mining literature will recall many recent instances of confusion and ambiguity.

In view of these facts I would like to submit the following questions to those who may be interested: Would it not be well to adopt another adjective to designate this

particular type of disseminated ore? Would not the word 'interstitial' meet the requirements of the case? In my opinion this word is equally as descriptive of the physical characteristics of the ore as 'porphyry,' and less objectionable.

W. N. THAYER.

Cincinnati, October 26.

Amortization of Mine-Capital

The Editor:

Sir—Referring to the article on 'Amortization and Depreciation' by Robert S. Lewis, in your issue of September 23. There is no doubt that it would be difficult, if not impossible, for a gold-mining company to plan a definite policy for the amortization of its capital. And it is safe to say that the average stockholder would prefer to do his own re-investing. If a company is formed to conduct a mining business and I acquire stock in that enterprise, as a mining venture, I question the right of my directors to re-invest my profits for me. On the other hand, the creation of a sinking-fund (out of profits) to provide for the purchase of other mining property, when a sufficient sum has been accumulated and a desirable property found, is a different matter from putting the profits into other enterprises with the intention of making a permanent investment. It is not a great stretch of the executive's prerogative from directing the method of exploitation of the parent property to acquiring other properties of the same nature.

It may be interesting to recall that an English company, formerly operating in California, successfully carried out this plan. As far back as forty years ago the Sierra Buttes Gold Mining Co. created a reserve-fund that was allowed to accumulate until such time as the directorate thought there was a favorable opportunity to put it into a new mining enterprise. Eventually, when the original properties were almost worked-out, the management bought a new mine with the funds saved for that purpose. Fortunately the new property thus acquired afforded an excellent use for the stockholders' money. Through it the directors were enabled to continue dividends for a number of years, and the life of the company was thereby prolonged in the business for which it was chartered.

San Francisco, November 2.

JOS. C. HOPPER.

SHEET mica finds its greatest use in the electrical industry, when an insulating, non-inflammable material is necessary. It is used in sheets and as washers and discs in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, in rheostats, fuse-boxes and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. It is necessary where an insulating medium is needed and where glass would be broken.

ORE MINED in British Columbia in 1915 was 2,690,110 tons, showing an increase from that of the previous year of 511,139 tons.

Engineers for the Officers' Reserve Corps

By A. H. Babcock

The great struggle in Europe emphasizes the lack of officers available for the augmented English Army, and therefore conveys a solemn warning to the American people: the English Army and the United States Army being based on much the same organization, namely, a skeleton in peace times, to be increased as may be required in war time.

"The almost studied indifference of the American people toward reasonable preparation for the contingency of war makes more urgent the duty of all officers or those who hope to become officers, to do all in their power in advance to prepare themselves and those committed to their care for the immense responsibilities that will rest upon them when the storm bursts upon the nation.

"The trend of history shows in general a progressive decrease in the length of wars due to the enormous massing of men now possible, and the increasing power of destruction of modern weapons. The decision, in short, is sooner reached. This being the case there is more than ever before a need for adequate preparation in advance of the outbreak of war. The unprepared people or government who now-a-days find themselves on the brink of hostilities with a nation that is trained for the struggle, must expect inevitably to pay a severe national penalty.

"The preparation of a nation for war is of two kinds: one of material things, the construction of forts, arsenals, fabrication of weapons, munitions, etc., the other the training of its people. And the second is more important than the first, though in the United States the estimate of their relative importance is reversed. The people of the United States are willing to vote immense sums for preparations that concern material, but they grudge time or thought devoted to the war training of the fighting unit—the man."*

On the third of June, 1916, Congress passed an Act "for making further and more effectual provisions for the National Defense." Regulations prescribed by the President to carry this into effect have been published by the War Department, General Orders No. 32, from which the following is largely abstracted. The Officers' Reserve Corps has been created for the purpose of securing a reserve of trained men available for service as temporary officers in the Regular Army. A member of this Officers' Reserve Corps will not ordinarily be subject to call for service in time of peace. It is expected, however, that reserve officers will be ordered to duty with the troops or at field exercises or for instruction for periods not to exceed 15 days in any one calendar year, and while so serving they will receive the pay and allowances of their respective grades in the Regular Army.

The act authorizes the President "to appoint and commission as Reserve Officers in the various sections of the Officers' Reserve Corps, in all grades up to and including that of Major, such citizens as, upon examination prescribed by the President, shall be found physically, mentally, and morally qualified to hold such commissions." The age-limits fixed for appointment and re-appointment are, for a Second Lieutenant, 32 years; a First Lieutenant, 36 years; a Captain, 40 years; a Major, 45 years. These age-limits shall not apply to the appointment or re-appointment of officers in the Quartermaster, Engineer, Ordnance, Signal, Judge Advocate, and Medical sections of the Reserve Corps.

Commissions will be issued for periods of five years; and when an officer of the Reserve Corps shall reach the age-limit fixed for appointment or re-appointment in the grade in which he is commissioned, he shall be honorably discharged from the service of the United States (unless re-commissioned in a higher grade).

In time of actual or threatened hostilities, the President may order officers of the Reserve Corps to temporary duty with the Regular Army, in grades thereof which cannot for the time being be filled by promotion; or as officers in volunteer or other organizations that may be authorized by law; or in such other duty as the President may prescribe; for example, the recruit, rendezvous, and supply depots. While on such service the reserve officers, by virtue of their commissions as such, will exercise command appropriate to their grade and rank in the organizations to which they may be assigned, and shall be entitled to the pay and allowances of the corresponding grades in the Regular Army, with such increases of pay as are allowed by law for officers of the Regular Army; and they may be promoted, in accordance with their rank, to vacancies in volunteer organizations or to temporary vacancies in the Regular Army thereafter occurring in the organization in which they shall be so serving, but they shall not be entitled to retirement or to retired pay and shall be entitled to pension only for disability incurred in the line of duty and while in active service.

The Sections of the Officers' Reserve Corps shall be designated as follows:

1. Infantry Officers' Reserve Corps.
2. Cavalry Officers' Reserve Corps.
3. Field Artillery Officers' Reserve Corps.
4. Coast Artillery Officers' Reserve Corps.
5. Medical (to include the reserve officers of the Medical Corps, Dental Corps, and Veterinary Corps) Officers' Reserve Corps.
6. Adjutant General's Officers' Reserve Corps.
7. Judge Advocate General's Officers' Reserve Corps.

*"Technique of Modern Tactics," Bond & McDonough.

8. Inspector General's Officers Reserve Corps.
9. Quartermaster Officers' Reserve Corps.
10. Engineer Officers Reserve Corps.
11. Ordnance Officers' Reserve Corps.
12. Signal Officers' Reserve Corps."

Every applicant will be subjected to a rigid physical examination and he will be rejected for any cause of disqualification that in the future might impair his efficiency as an officer; but defects of vision resulting from errors of refraction, which are not excessive and which may be corrected by glasses, do not disqualify unless they are due to organic disease. In general the examination as to physical qualifications will conform to the standard required for recruits in the United States Army. Before making the examination the applicant will be required to submit, for the examination of the Board, a certificate as to his physical condition, which, in case no disqualification exists, will be a simple signed statement from the applicant that to the best of his knowledge and belief he is not affected with any form of disease or disability that will interfere with his proper performance of the duties under the commission for which he is applying.

No applicant will be examined who is an officer of the Regular Army on the active list, or of the National Guard, or who is not a citizen of the United States. The lower age-limit below which examinations will not be made is, for the Second Lieutenant, 21 years.

The examinations in all subjects will be oral or practical, or both; but in certain cases applicant is authorized to call for a written examination, if he so desires. Emphasis is laid upon the fact that the examination shall be specially directed to ascertain the practical capacity of the applicant, and the record of his previous service and training shall be considered a part of the examination.

Engineers, as such, are interested more particularly in the Coast Artillery, Quartermaster, Engineer, Ordnance, and Signal Corps. As a guide to the preparation required, examinations in the Coast Artillery Corps will refer to Army Regulations and important General Orders, Drill Regulations, Field Service Regulations, Explosives, Electricity. For the higher grades of the service this examination will include, in addition to the foregoing, elementary and applied mechanics, care and operation of steam boilers, steam engines, and internal-combustion engines; the theory, care, and operation of dynamos, storage batteries, telephones, and searchlights; from which it would appear that both mechanical and electrical engineers should be largely interested in the Coast Artillery work.

For the Engineer Corps the applicants will be divided into two classes:

- (a) For duty with combatant engineer troops, or other duties in the service of the front; or
- (b) For special service on the lines of communication or other points in rear, including engineer work with sea coast defenses as hereinafter indicated."

Ordinarily, officers appointed under (b) will not be assigned to combatant duties, but they will be subject to such assignment whenever needed. The reasons for this provision will appear later, when the responsibilities of the engineer officers under the two classes are considered.

Under (a), Service of the Front, an applicant for a commission as First or Second Lieutenant must be an engineer in the active practice of his profession or in some business immediately connected with or concerned in engineering matters. He must either hold or have qualified for the grade of Junior Engineer—civil, electrical, or mechanical—or of some higher grade in the Civil Service, or he must be a graduate from an approved engineering college or have been in the active practice of engineering for at least two years.

An applicant for a commission as Captain, in addition to the requirements for Lieutenant, must either hold or be eligible for the grade of Assistant Engineer in the Engineering Department at Large, or a corresponding engineer grade in the Civil Service or another Department of Government Service, or have held a commission in the Corps of Engineers of the Regular Army; or he shall be a professional engineer not less than 28 years of age, who shall have been in the active practice of his profession for at least eight years and have had responsible charge of work, as principal or assistant, for at least two years; he must have knowledge of the principles of Military Organization and Operations, in Infantry Drill and Field Service Regulations, and of the general principles of Field Fortifications as illustrated in the Engineer Field Manual.

For Major, in addition to the requirements for Captain, he must have held a commission in the Corps of Engineers of the Regular Army, not more than two grades below that for which he desires to be listed; or he shall be a professional engineer not less than 35 years of age, who shall have been in the active practice of his profession for 15 years, who shall have had responsible charge of work for at least five years and he shall be qualified to design as well as to direct engineering work. Furthermore, he must have knowledge of the duties of engineer officers and troops in war, as illustrated in the Engineer Field Manual, and in certain other publications mentioned in the Act. Under class (b), Special Services, he must be qualified for at least one of the duties assigned to the Corps of Engineers by the following extracts from Army Regulations:

"The duties of the Corps of Engineers comprise reconnoitering and surveying for military purposes, including the laying out of camps; selection of sites and formation of plans and estimates for military defenses; construction and repair of fortifications and their accessories; * * * the installation of electric power-plants and electric power-cable connected with seacoast batteries; * * * construction and repair of military roads, railroads, and bridges; military demolitions; * * * In time of war within the theatre of operations it has charge of the location, design, and construction of wharves, piers, fuel-docks, store-houses, hospitals, and other struc-

tures of general interest, and of the construction, maintenance, and repair of roads, ferries, bridges, and incidental structures, and of the construction, maintenance, and operation of railroads under military control, including the construction and operation of armored trains."

"No oral or professional examinations will be required, but recommendations of boards will be required in lieu of such examinations. Candidates will submit evidence of their actual employment in corresponding or higher positions in civil life and references to persons under whom they have been or are employed. The boards will communicate with such persons and with any others that they deem fit, and upon all the evidence submitted or otherwise obtained will base their recommendations and recommend the appropriate grades for which they deem the successful candidates qualified.

"Military experience or training in the Regular Army, Volunteers, or National Guard, or at training camps or educational institutions will be noted and reported by the board and considered in making the recommendations.

"Reserve officers from the following civilian occupations will be required for the special services of the Corps of Engineers:

Bridge engineers.

Constructing engineers (earth and concrete).

Constructing engineers (wharves, piers, and buildings).

Electrical engineers (for small plants and power-lines).

Highway engineers.

Mining engineers (skilled in tunneling and use of explosives).

Railroad engineers (construction and maintenance).

Railroad operating officials.

Sanitary engineers.

Topographical engineers."

Engineers of telephone and telegraph companies will be directly interested in the Signal Corps, examinations for which, in the lower grades, will include the same administration subjects as for the Infantry officers; also regulations and laws pertaining especially to the Signal Corps. They will be examined both orally and practically in theoretical and practical knowledge of modern methods of visual signaling, including the ability to transmit and to receive messages by flag, lantern, and heliograph.

Telegraphy and telephony include theoretical and applied knowledge of electricity and telegraphy, covering installation and repair of telephones, testing for faults, maintenance and operation of permanent telegraph, telephone-lines, and of field-lines; skill in transmission and receipt of messages on telegraph-lines; oral and practical examinations concerning dynamos and batteries, also radio-telegraphy. They will be required to have some knowledge of map-reading and field-sketching.

For Majors the examination will be the same as the foregoing, but in addition they will be required to show

knowledge as to material, cost, time, etc., and method of constructing a permanent telegraph-line in such portion of the United States as may be designated; knowledge of a scheme for assembling, organizing, and transporting a mobile telegraph-train for building light semi-permanent lines for telegraph or telephone communication under conditions to be designated by the Examining Board. They will be required to have a knowledge of engines, boilers, internal-combustion engines, and automobile traction.

For the special services in the Aviation Section, Reserve officers selected from civilians engaged in the following occupations will be needed: Aviators, aeroplane designers, motor designers, experts in aero-photography and radio-communications, aeronautical engineers and balloonists.

Probably the section of the Reserve Corps of most general interest will be the Quartermaster Corps, to qualify for which an applicant will be examined for duties that require either a knowledge of administrative and clerical detail, or for special services of a business or professional nature requiring no special military knowledge. The first class will receive a mental examination to test their fitness for the peculiar services required; the second class will not be subject to mental examination, and, as has been stated previously, neither class is subject to age limits, but both are subject to physical examination.

In the first class the scope of the examination will cover general duties as exemplified in the United States Army Transport regulations and circulars of the Quartermaster General's Office relating to supplies, payment and services, subsistence, and pay manuals. The applicant will be furnished blanks and will be required to exemplify their use in the preparation of contracts, bonds, returns, accounts current, etc. Military Law; oral examination will cover the ground of Manual of Court's Martial, the Law of War, Civil Functions and Regulations of the Military, and General Instructions for the Government of the Armies of the United States in the Field; also on the Cavalry Horse, Draft Horses and Mules—their inspection and purchase, care, feeding and watering; also the construction, lighting, and ventilation of stables; the different kinds and relative value of forage, its inspection, proper care and causes of deterioration; also on transportation by land (rail, wagon, and pack) and by water; the care of animals on cars and transports; construction and repair of roads, railroads, and bridges.

For those whose duties are not administrative there will be required merely a knowledge of and experience in one of the trades or lines of business, as follows:

"Railroad—

(a) Traffic manager, commercial.

(b) Accounting department, railroad.

(c) Operating department, railroad.

(d) Mechanical department, railroad.

(e) Other capacity, not named above, railroad.

"Navigation companies and merchant vessels—

(a) As manager.

- ☐ b) As port captain
- ☐ c) As superintending engineer
- ☐ d) As chief steward.
- ☐ e) As marine superintendent
- ☐ f) As inspector of construction and repairs.
- ☐ g) As estimator on marine repairs.
- ☐ h) As superintendent of docks, warehouses, etc.
- ☐ Auto truck transfer companies
- ☐ Auto truck freight companies
- ☐ Warehouse and terminal companies
- ☐ Animal industry
 - ☐ a) Purchasing horses and mules
 - ☐ b) Shipping horses and mules.
 - ☐ c) Breeding and raising horses and mules.
- ☐ Wholesale food and grain business.
- ☐ Wagon, machine, or other factories.
- ☐ Harness factory.
- ☐ Auto truck repair-shops or factories.
- ☐ Automobile repair-shops or factories.
- ☐ Ship construction or repair firms.
- ☐ Wholesale grocery business.
- ☐ Wholesale clothing business
- ☐ Wholesale shoe business.
- ☐ Clothing manufactory
- ☐ Shoe manufactory.
- ☐ Hat manufactory.
- ☐ Auto-truck manufactory.
- ☐ Packing houses or factories
- ☐ Shop management and its nature.
- ☐ Official of large restaurant or hotel company.
- ☐ President, secretary, or manager of any large business, whatever its nature.
- ☐ Official of any department of a large business.
- ☐ Building company
- ☐ Construction company
- ☐ Civil engineering
- ☐ Mechanical engineering
- ☐ Sanitary engineering
- ☐ Electrical engineering
- ☐ Structural engineering
- ☐ Banks or banking firms or corporations
- ☐ Financial or cashier departments of railroads or other transportation companies, corporations, or other large business concerns

"Any other industries or business not mentioned above that may make the applicant a desirable officer of the Quartermaster Corps in time of war."

The Examining Board will carefully consider the documentary evidence furnished by the applicant, and it may require additional information by personal questions as to his business experience and other pertinent matters. The Board may call also for additional documentary or oral evidence bearing on the suitability of the applicant for his commission.

Railroad officials and engineers are particularly interested in the distinction between the Engineer Corps and the Quartermaster Corps as applied to railroading. In time of war (actual or threatened) the Federal Government undoubtedly will take charge at once of all

railroads in or near the threatened territory, which will be divided into two sections, namely, the theatre of operations and the lines of communication, which, in general, is the connecting link between the field of action and the base, and through which must pass all of the men, materials and supplies required for use in prosecuting the campaign.

A railroad involved in the theatre of operations is managed and operated by the Engineer Corps; a railroad outside the theatre of operations, but involved in the line of communications, is operated by the Quartermaster Corps. Any railroad so involved must expect in such times to have on its staff, officers responsible to the War Department in either one of the corps mentioned, to represent the Department in its operation. If a sufficient number of railroad officials qualify for duty and are commissioned in the Officers' Reserve Corps in either of the sections named, the only change in its personnel that it may expect will be to see certain of its officers in army uniform instead of in civilian clothes; and conversely, a railroad in which there is insufficient representation in the Officers' Reserve Corps may expect to find army officers detailed to take charge.

When the close inter-dependence between all public utilities is considered, transmission companies and communication companies may expect to have similar situations confront them. It would appear, therefore, prudent, as a part of the general preparedness movement, that all public utility companies should encourage their officers to apply and to qualify for commissions in the Reserve Corps, and thereby insure to the companies a minimum of disturbance in administration in case of hostilities.

Engineers now have offered to them their opportunity to give their services to their country most effectively, when she will have most need of them, with the assurance that they will be given responsibility and rank commensurate with their experience and ability. Some hard digging is involved for those who have not had military training or who have forgotten much of their early experiences. The Army officers who have in hand the instruction of reserve officers do not expect us to be experienced; they expect to give us experience. All they ask of us is to be willing to learn and to give up some of our spare time to this end. In return we are assured of preferred opportunity to obtain a commission in the Regular Army, when the Army needs us, with rank and corresponding pay while on duty, appropriate to our abilities and responsibilities.

Furthermore, these same officers have given assurance that the preliminary examinations are not to be designed to keep men out of the service, but to help them to get in most effectively, that is, where they fit best. Once entered, it is up to the individual to go ahead or to stand still.

The question may be asked, why do it at all? The answer is, if there is real trouble there will be enough to go around, which means that every man will have "to do his bit."

The Ore Deposits of Mohave County, Arizona

By Frank C. Schrader

INTRODUCTION. *This region, commonly known as the Mohave district and Kingman district, lies in western Arizona in the southern part of Mohave county, and borders California and Nevada on the west. Kingman, the principal town, is situated near the centre of the area on the Atchison, Topeka & Santa Fe railway.

This region is composed of naked mountains and broad detritus-filled valleys, the southern extension of the characteristic topography of the Great Basin. In altitude it varies from 500 ft. in the south-west to 8300 ft. on Hualapai Peak south-east of Kingman.

The mountains trend north-northwest. They rise about 3000 ft. above the valleys, are generally rugged, and were formed mainly by erosion. They are composed in the main of a complex of pre-Cambrian granitoid rocks that underlies the area as a whole. Like the valleys, they average about 10 miles in width.

GEOLOGY. The rock groups beginning with the oldest are the pre-Cambrian complex, Paleozoic sediments, pre-Tertiary intrusives, Tertiary volcanics, and Tertiary (?) and Quaternary sediments. The first and third of the divisions named are the most important.

The pre-Cambrian complex consists of gray gneissoid granites. Coarse gold-bearing detrital formations, or 'wash,' locally 2000 ft. thick, partly fill the inter-montane valleys.

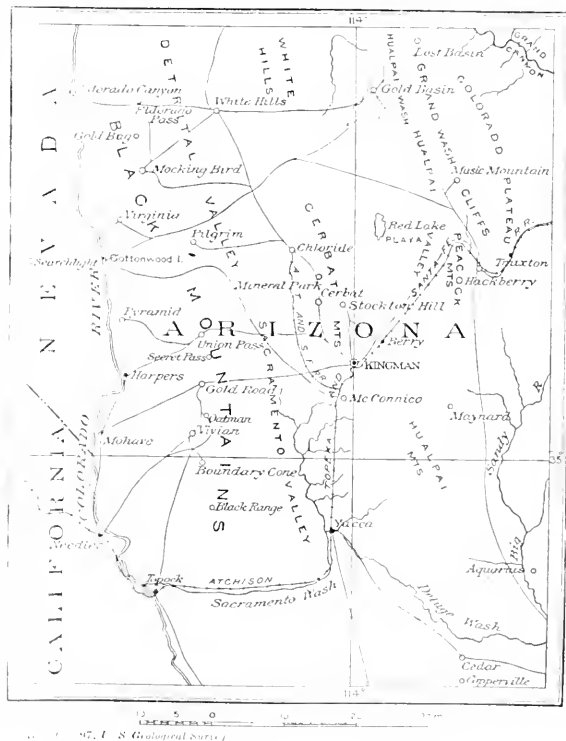
Locally intruding the pre-Cambrian rocks are pre-Tertiary igneous masses and dikes thought to be of late Jurassic or early Cretaceous age. They occur chiefly in the Cerbat mountains and are connected with the genesis of the deposits. The most important are granite-porphphy, a light gray medium-grained rock, and lamprophyric rocks, the latter occurring mainly as dark, complementary narrow dikes accompanying the acidic intrusives.

The Tertiary volcanics consist mainly of andesites, trachytes, rhyolites, and latites, lying in broad superimposed sheets, flows and beds locally aggregating 3000 ft. thick. They are best developed in the Black mountains, particularly in the southern part. They contain most of the mineral deposits of the range and played an important part in their genesis.

The beginning of mining in the Mohave area dates from the finding of ore at the Moss mine, four miles

north-west of Gold Road in the early 'sixties. From 1904 to 1914 the production was nearly \$16,000,000, of which \$11,500,000 was gold, nearly all derived from the Tom Reed and Gold Road mines. Besides gold and silver, zinc, lead, copper, tungsten, molybdenum, and bismuth are produced.

THE TOM REED-GOLD ROAD district lies about 25 miles



MAP OF ARIZONA MINING DISTRICTS.

south-west of Kingman, mainly on the west slope of the range; it comprises what was formerly known as the Gold Road and Vivian districts, the area being approximately co-extensive with the southern part of the San Francisco district of early days. The principal centres of activity are Oatman, the settlement of the Tom Reed and neighboring mines, and Gold Road, two miles north of Oatman.

Mineral was first discovered in the early 'sixties at the Moss mine, four miles north-west of Gold Road. This mine soon produced \$240,000 in gold from rich surface ore. Production has continued since the discovery of

*Abstract from paper to be presented at the New York meeting (February 1917) of the American Institute of Mining Engineers.

¹A fuller description of the rocks appears in Bulletin No. 397, U. S. Geological Survey (1909).

the Gold Road mine in 1902. Recently discoveries in the Tom Reed mine and vicinity have been attracting attention, with the result that the value of the plants and machinery at the various mines is said to aggregate nearly \$2,000,000. Some 50 odd plants are in operation. Most of them have been installed since the first of the year 1915, during which time nearly 200 companies have been organized to operate in the district, of which 150 are fully equipped and most of the others are receiving machinery. Thirty or more properties hitherto dormant have become active, and the population, which is gathered from all the mining camps in the West, has increased from 500 to more than 7000, and is increasing.

The approved method of prospecting is to sink to depth, of 300 to 500 ft. and then cross-cut and drift. Practically no surface work is done. Usually also much lateral development must be done before pay-ore in large quantity is found and the mine proved. The automobile, a prominent feature in the present activity, has taken the place of the burro in prospecting.

The cost of mining and milling is about \$6 per ton, of which \$1.25 is for power. The larger mines use electric power supplied by the oil-burning plant at Kingman. At the Gold Road mine, treating 200 tons of ore daily, the best record obtained for mining and milling is slightly less than \$3 per ton. At the Tom Reed mine, however, where 20 stamps are used, the cost is about \$6. There is said to be no profit in treating \$5 ore on a small scale. Both the Gold Road and Tom Reed mines treat their ore by the cyanide process, and have installed the counter-current decantation system.

From what has been said of the Tyro and Gold Road veins, and from the large number of other widely distributed profitable orebodies being found at depth, and the cost of mining and milling, this is not a locality for the small operator but seems rather to offer encouraging possibilities for capital to engage in deep mining.

GEOLOGY. Tertiary volcanic rocks prevail, particularly in the eastern portion of the district. They practically constitute the range, dip gently eastward toward its axis, and are in places covered by younger rhyolite, andesite, and basalt. In the southern part the green chloritic andesite is dominant, while on the west occur local areas of the pre-Cambrian gneiss, younger granite-porphry and micro-pegmatite, greenstone conglomerate, and overlying sheets of supposed Tertiary conglomerate, younger gravel and lava flows. Locally intervening between the pre-Cambrian and the overlying volcanics are occasional patches of tilted and metamorphosed Paleozoic limestone and shale belonging to the Grand Canyon section. These sedimentary rocks are not as yet known to have any bearing on the deposits or on mining other than to indicate to the miner the lower limit of the volcanics.

Recent mine developments show that the geology of the ore-bearing volcanics is more complicated and seemingly of more importance than was at first supposed.

In the vicinity of Vivian, and from there toward Oatman, occurs the older or basal andesite, which is light

gray, calcitic, 300 ft. thick, and rests mainly on the pre-Cambrian complex and Paleozoic sediments. The older andesite, however, is not known to be of wide extent in the district, a fact overlooked by Bancroft and others. It is absent from Secret Pass where the next higher rock, the green chloritic andesite, rests directly upon the pre-Cambrian granite, and from the Hardy mountains, where the green chloritic andesite similarly rests upon the Mesozoic granite-porphry or micro-pegmatite.² It is not known to be present at the Gold Road mine, and according to Sperr³ the rock underlying the green chloritic andesite in the deep workings of the Tom Reed mine does not correspond with the older andesite described at Vivian. The older andesite is succeeded unconformably by another series of flows, the green chloritic andesite, which contains an important part of the mineral deposits in the Tom Reed-Gold Road district. The flows aggregate a known thickness of 800 ft. The rock consists mainly of a greenish fine-grained groundmass containing abundant whitish feldspar phenocrysts. It is chloritic and calcitic. It is intruded by black latite and younger lavas.

The intrusive nature of the green chloritic andesite and association of ore deposits with its intrusive phases in various parts of the district are also abundantly corroborated off from the main mass, extend $\frac{1}{2}$ mile or more westward into the older andesite. A black fresh-looking specimen of it from the Leland mine proved to be latite; it contains chlorite in abundance throughout.⁴

The intrusive nature of the green chloritic andesite and association of ore deposits with its intrusive phases in various parts of the district are also abundantly corroborated by the later work of Sperr, Probert, Bancroft, and other engineers. Probert⁵ believes it to be both intrusive and extrusive, that dikes and sills of it occur in the older andesite, and that mineralization is dependent upon this association.

Bancroft⁶ writes that in the vicinity of the various mines which he examined he found evidence of the intrusive nature of this formation, and that the orebodies are largely formed within the intrusive.

More recently, according to Smith,⁷ the bottom as well as the collar of the Tom Reed shaft at 1075 ft. in depth was in the green chloritic andesite, which in the bottom of the shaft was ore-bearing, and he suggests that the rock may here be intrusive. The supposition of the rock being here intrusive, probably as a neck, would help to account for the unusual thickness of the formation at this point, which seems to be local, since elsewhere in the

²Bulletin No. 397, U. S. Geol. Surv., p. 35, and Fig. 2 (1909).

³J. D. Sperr: 'The Tom Reed-Gold Road Mining District, Arizona,' *Eng. and Min. Jour.*, vol. 101, No. 1, pp. 1-5 (Jan. 1, 1916).

⁴Bulletin No. 397, U. S. Geol. Surv., pp. 36-37 (1909).

⁵Frank H. Probert: 'Oatman, Arizona—A Prohibition Camp,' *M. & S. P.*, vol. 112, No. 1, pp. 17-20 (Jan. 1, 1916).

⁶Howard Bancroft: 'Geology of Gold Road District,' *M. & S. P.*, vol. 3, No. 1, p. 21 (July 3, 1915).

⁷Howard D. Smith: 'The Oatman District, Arizona,' *M. & S. P.*, vol. 3, No. 5, pp. 172-175 (July 31, 1915).

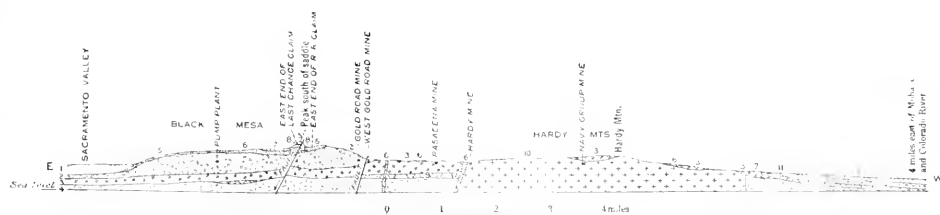
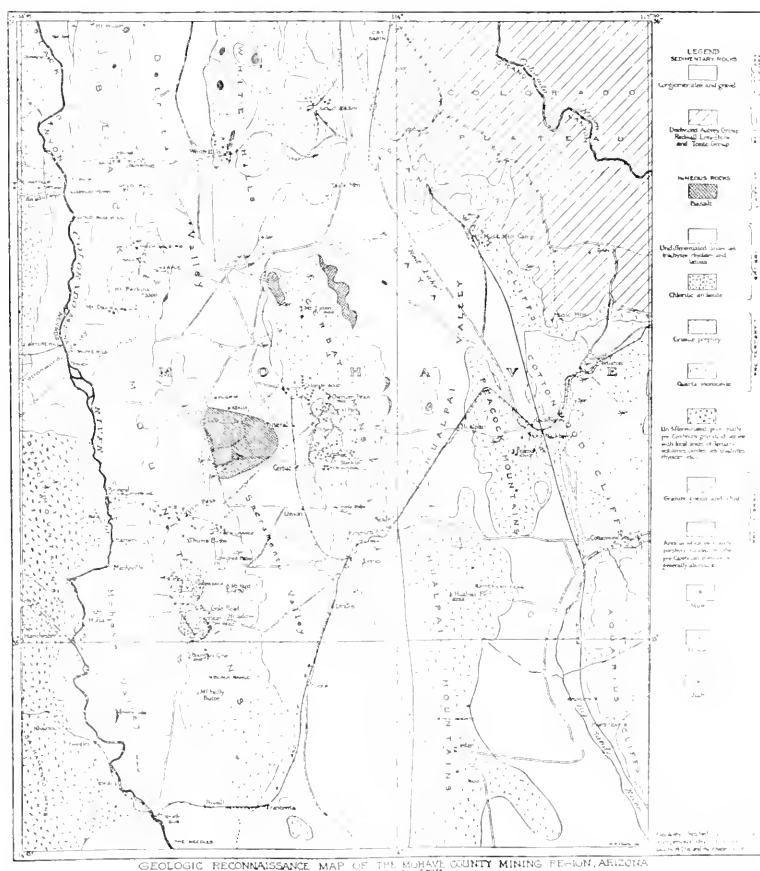


FIG. 2. GENERALIZED SECTION ACROSS BLACK MOUNTAINS. U. S. GEOLOGICAL SURVEY.

1, Sands and gravels; 2, undifferentiated volcanic rocks; 3, green chloritic andesite; 4, gneissoid granite; 5, basalt; 6, rhyolite; 7, young andesite; 8, rhyolite tuffs; 9, andesite and andesite tuffs; 10, granite porphyry and micro-pegmatite; 11, conglomerate.



GEOLOGIC RECONNAISSANCE MAP OF THE MOHAVE COUNTY MINING REGION, ARIZONA

Tom Reed mine and in the neighboring United Eastern, Pioneer, and other properties the workings, according to Schader,⁸ passed through the green chloritic andesite and into the older underlying andesite at shallower depths and have workable ore in the lower rock.

Therefore, according to the observations of six or more investigators, the green chloritic andesite includes rocks that vary considerably from the normal andesite, rocks

with which the ore deposits in general seems to be associated and which are known to be intrusive into the older andesite. The most important of these rocks seems to be the dark latite at the Leland mine and elsewhere. It seems to intrude not only the older andesite but also the green chloritic andesite as sheets, necks, and dikes, and to be intimately connected genetically with the ore de-

⁸J. D. Sperr: 'Conversational Geology at Oatman,' *Eng. & Min. Jour.*, vol. 101, No. 26, p. 1119 (June 24, 1916).

⁸Carl F. Schader: Personal letter, Feb. 6, 1915.

posits. More recently, Sperr⁹ regards all the commercial ore as occurring in the andesites intimately associated with latites. The intrusive nature of the rocks associated with the ore deposits obviously favors continuity of the deposits in depth.

The deposition of the green chloritic andesite was followed by a period of great fissuring and faulting accompanied and followed by eruption of the next higher group, the undifferentiated volcanic rocks 2000 ft. thick, containing the Gold Road and other important veins, and by intrusions of younger rocks, especially latite and rhyolite in the form of dikes, necks, and rounded plug or stocklike masses, and the making of many of the larger fissure veins. The undifferentiated volcanics are succeeded by a series of younger light-colored tuffaceous rhyolites locally 1000 ft. thick, known as the 'water rock,' succeeded by dark reddish andesite, which in turn is followed by black olivine-basalt, the youngest of the effusive rocks, which remains as a cap over a large part of the Black Mesa mountains.

THE ORE DEPOSITS, which are numerous, are chiefly gold-bearing fissure-veins. They vary from 5 to 70 ft. in width and from a few hundred feet to several miles in length. In general they are strong and persistent. They strike north-west with steep dip north-east. They are almost devoid of metallic sulphides, the gold being free. They occur chiefly in the lower part of the undifferentiated volcanic series, the green chloritic andesite, the granite-porphry, and micro-pegmatite, other underlying rocks, and also along contacts where latite and rhyolite are the intrusives. Some of the deposits are rich, but the large bodies of low-grade ore constitute the main resource. Ore having a metallic content of \$10 or less is considered low-grade.

The older andesite, from the ill behavior and feathering out of certain vein deposits on entering it from the green chloritic andesite, was originally regarded by me as unfavorable for mineral or essentially barren, particularly in the Vivian district. Owing to its tuffaceous brecciated and fragmental nature it is almost devoid of lava cooling shrinkage-cracks and fissures, which elsewhere form favorable repositories for ore. According to Palmer¹⁰ "the occurrence of any ore shoots in the earlier (older) andesite is yet to be demonstrated." E. W. Brooks also limits the area of commercial mineralization in this part of the district to the green chloritic or 'younger andesite.' Later developments, however, in the Oatman and Vivian camps, disclose workable ore deposits in the older andesite also. My belief that major veins probably occur in and below this formation is shown by the following statement: "The veins cut through the great mass of Tertiary volcanic rocks which characterize the range and undoubtedly continue in depth into the underlying pre-Cambrian granitic rocks."¹¹

According to Palmer,¹² "there is no doubt that the

veins extend into the pre-Cambrian and some ore of value has been found therein."

Since the deposits are confined to the vein-filling and do not as a rule form metasomatic replacements in the wall-rock, as at Cripple Creek, the selective preference which any bounding wall-rock, by reason of its more favorable physical or chemical properties for replacement, may exert in favor of ore deposition seems to be practically nil. Accordingly, there is no apparent reason, other conditions being equal, why the deposits should not be equally developed in any one of several formations through which the fissure-vein with like strength may extend.

The deposits consist of two types: those in which the gangue is chiefly quartz and adularia, and those in which it is chiefly calcite. The source of the quartz and adularia is referred to the silicious magmas and that of the calcite to basic or andesitic magmas with possible contributions derived from underlying limestones. The former carry the best ore, occur mostly in the undifferentiated volcanic rocks and in granite-porphry and have a general north-west south-east trend. The latter seem to occur mainly in the green chloritic andesite and trend more nearly north-south. Among the most important of the former type are the Gold Road and Tom Reed veins; among the latter, the Pasadena, Mossback, and Meals. In some cases the veins are associated with boldly cropping silicified dikes of which the deposits in certain instances may be a part replacement.

According to Platts,¹³ the most productive veins, such as those in the Tom Reed, United Eastern, and Big Jim mines, are in a complicated series of fissures, part of which strike about N 45° W, and others N 60° W, producing with each other a conjugated system with numerous intersections near which many large orebodies are found.

Superficially, the veins seem to fall mostly into four main belts,¹⁴ which, named in order from north to south, are the Gold Road, Tom Reed, Vivian, and Black Range. The Tom Reed belt is the best developed and contains the most interesting discoveries.

There seem also to be two or more horizons or vertical 'ore-zones.' The largest and richest orebodies seem in general to lie in a zone of enriched oxides between the 300-ft. and 500-ft. levels. Below this zone the ore decreases in value, but continues to be of workable grade beyond the deepest point yet penetrated. The richness of this zone as suggested by Smith¹⁵ is probably due to secondary enrichment, by contributions leached from shallower depths, in support of which the presence of vugs and manganese oxide in the upper part of the veins is cited. This view is also corroborated by the tendency of the zone to parallel the contour of the surface. For instance, its occurrence at about the same distance from the surface in the Gold Road mine as at Oatman, though

⁹Leroy A. Palmer: 'The Oatman District, Arizona,' M. & S. P., vol. 113, No. 6, p. 195 (Aug. 5, 1916).

¹⁰Bulletin No. 397, U. S. Geol. Sur., p. 18 (1909).

¹¹Leroy A. Palmer: *Op. cit.*, M. & S. P., vol. 113, No. 6, p. 195 (Aug. 5, 1916).

¹³J. B. Platts: 'Geology of Oatman,' M. & S. P., vol. 112, No. 23, p. 814 (June 3, 1916).

¹⁴Leroy A. Palmer: 'The Oatman District, Arizona,' *Eng. & Min. Jour.*, vol. 101, No. 21, p. 895 (May 20, 1916).

¹⁵*Op. cit.*, p. 173.

at correspondingly greater elevations and higher geologic horizons. The gold was probably precipitated in large part along with the manganese oxide.

If the thickness of 600 or 800 ft. assigned to the green chloritic andesite be correct, this Oatman ore-zone, or, more generally speaking, the triangular area of several square miles comprised between the Tom Reed, Pioneer, and Pasadena mines, should lie mainly in this formation. There seems to be also present, notably at Oatman and vicinity, a shallow or surface zone of leached oxides to which pay-ore found at or near the surface is generally confined. It extends to depths of about 150 ft., between which and the zone of enriched oxides, or 300-ft. level, lies a 150-ft. intermediate zone of leached or relatively barren ground, although the valuable ore-shoots, according to Sperr,¹⁶ almost without exception come at least within 100 ft. of the surface.

These two zones have probably suffered about the same amount of leaching, the upper zone certainly not less than the intermediate or barren zone. The upper zone appears to owe its greater ore-content to the more silicious, and consequently resistant, character of the ore, which accordingly better withstands the process of leaching.

As against the view of enrichment by leaching and re-deposition in the main zone of Platts¹⁷ who holds that the ore is essentially a primary deposit formed by hot ascending solutions, that from the nature of the gangue it is evident that acid solutions could not exist, and that, except for the oxidation of the pyrite, there is no evidence of the action of surface-water on the ore.

It seems quite possible, as suggested by one writer, that the ground-water table in the district may be in part dependent upon the neighboring Colorado river. If this view be correct, physiographic study will probably be able to correlate certain horizon features of the vertical section such as leaching, with relatively prolonged pauses in the historical down-cutting of the river. It does not, however, seem safe to assume that the water-table at Oatman coincides with the level of the Colorado river, which is 2000 ft. lower than Oatman, and that therefore the ores, if they persist downward, will continue to be oxidized and of the same milling character to that depth as advocated by Palmer.¹⁸ Owing to the greater elevation of the gathering zone on the east, which probably extends to the Hualapai mountains, or longitude of Kingman, the ground-water table is not a level surface, but gradually rises from the Colorado river, eastward, and at Oatman it probably stands several hundred feet above the level of the river.

The ore occurs chiefly as a series of tabular or lenticular ore-shoots pitching variously within the vein, with which they exhibit some degree of parallelism. The shoots vary from 1 ft. wide to the width of the vein. They usually carry gold for their full width. They

range up to nearly 1000 ft. in length and depth, and there is a general similarity or repetition of the shoots in the same vein. They seem to have been formed by thermo-aqueous processes that followed igneous activity. In general, the quartz and values favor the hanging wall, which is generally the better defined, and contains stringers branching off obliquely from the vein, while the spar or calcite favors the foot-wall. The gold is mostly associated with the quartz-adularia gangue and not rarely where sulphides have existed, it, according to Platts,¹⁹ occurs in hematite (which is pseudomorphic after pyrite) in the quartz.

According to Palmer,²⁰ the first indications of the vein encountered in sinking are small stringers of quartz and calcite scattered through the andesite, usually accompanied by slight pyritization in the vein-wall andesite which yields a little free gold in the pan, while in the ore-shoots the vein matter shows pronounced hematite and manganese stains. It is said that the problem in development is not so much the finding of veins as the discovery of ore-shoots in the veins, that nothing sufficiently tangible has yet been found to use as the basis for a theory to guide the operator in the search for ore.

Though no rigid rule can be laid down to guide the operator in search for ore, nevertheless, from the apparently well-established facts that the metallic values have been largely imported by the replacement quartz-adularia solutions and that more gold is found where the replacement of calcite is most nearly complete, in formulating plans of exploration much benefit in most cases should be derived from a correlative study of the criteria indicating the probable courses followed by these solutions, namely, quartzose vein croppings, silicified wall-rock, the quartz pseudomorphic structures, etc., which have been described. It was the quartz adularia or silicious waxy-appearing character of the deposits seen in the Tom Reed mine and the recognition of their marked similarity to the then-producing deposits of the Gold Road mine that apparently led to the resumption of operations in the Tom Reed mine.

THE mine of the Vermont Copper Company at South Strafford, Vermont, is one of the oldest mines in the United States, having been first opened in 1793. The ore was mined to make copper sulphate and over 1300 men were employed at one time. More recently it has been operated intermittently as a copper mine, but owing to difficulties in smelting at each attempt, the mine was shut-down. The ore is pyrrhotite, carrying 2 to 2.75% copper as chalcopyrite. Some experiments were made last spring in treating this ore by pyrite smelting, and these experiments were successful. The mine is now under development to increase the tonnage available before further improvements are made.

TAILING is treated in Cornwall for its tin-content, and during August, 10,876 tons yielded 37.3 tons of black tin, containing 70% metal.

¹⁶J. D. Sperr: 'Conversational Geology at Oatman, Ariz.' *Eng. & Min. Jour.*, vol. 101, No. 26, p. 1119 (June 24, 1916).

¹⁷J. B. Platts: *Op. cit.*

¹⁸L. A. Palmer: *Op. cit.*, M. & S. P., vol. 113, No. 6, p. 196 (Aug. 5, 1916).

¹⁹J. B. Platts: *Op. cit.*

²⁰L. A. Palmer: *Op. cit.*, p. 896.

The Importance of Efficient Settling of Slime

By Paul W. Avery

In many cyanide plants where fine grinding is practised, the thickening of the slime to a 1:1 or a 1:1½ ratio (solid : liquid) is often a serious problem. I say 'serious' because a thick pulp for the filters is imperative in order to secure quick filling and a good uniform cake. It is also serious from the standpoint of dissolved metal, cyanide, and water losses.

The filter-press in many slime plants is the determining factor of the daily tonnage to be treated, and every condition that tends toward shortening the press-cycle with good results metallurgically, is most desirable.

Thin pulp-feed decreases filter-press capacity, sometimes to an alarming degree. In one instance observed by me, 30 minutes was required to charge with a thin pulp and only 10 minutes with a thick one. Sometimes thin pulps are the result of carelessness on the part of the mill-man, he deeming it an unnecessary detail to take specific gravities at regular intervals. It is quite a simple thing to make this only a matter of routine. In Mexico and in Central America I have trained *peones*, who could hardly read or write, to take specific gravities with accuracy. We were able thereby to control the work of the thickening devices to a notable degree.

To me the securing of a thick pulp for press-feed is the most important thing in shortening the cycle. Just how to secure a thick pulp is a puzzle when one finds by experiment and actual mill-runs that the economic limit of slime-settling is around 1½ or 2:1 (S : L) on continuous discharge from the Dorr thickeners.

Manufacturers of filters usually insist that the feed must be 1:1 or better to get the requisite capacity out of their press. Often upon starting a new plant, to the chagrin of all concerned, the press falls down on its rated capacity by 25% or more. Blame is placed immediately by the mine management on the manufacturer of the filter, who, to vindicate his claims, sends a

representative to straighten out the difficulty if possible. Nine times out of ten he finds that the changes necessary are not in his department, but in the thickening end of the plant, where perhaps he discovers the specific gravity of the press-feed to be around 1.25 or 1.30, requiring three times as long to charge the press as with a feed of 1.45.

This factor is most important, and is often disregarded by mill-men. One small plant, which I investigated recently, raised its tonnage nearly 100% by close observance of this important detail. In order to find the economic limit of settling of a slime, I think the method described by M. D. H. Forbes in the *Engineering & Mining Journal* of February 24, 1912, is a good one to follow. In the March Bulletin of the American Institute of Mining Engineers, H. S. Coe and G. H. Clevenger have a splendid paper on the latest research in this department of cyanidation.

I shall give a brief outline of how we determined the economic limit of settling on the several slimes we have at this property and the changes we are making in the hope of overcoming the conditions previously outlined.

Seven different slimes were treated in the series of settling tests, the results of which are plotted in the large curves on the left-hand side. These slimes have the following names: San Carlos Sulphide, Oxide Slime Dump, Sand Dump, Descubridora, San Rafael Hanging-Wall Fills, West Vein Sulphide Fills, Main San Rafael (virgin ore). The ordinates are represented by percentages, namely, the volume of the clear water in centimetres divided by the volume of the pulp in centimetres, the abscissa being represented by dilution of the pulp or grams of solids per litre.

The following (Table I) is a tabulation of the tests on one slime from which the corresponding curve on the diagram was plotted. It will be observed that tests

TABLE I
SETTLING TESTS—SAND DUMP

Dilution gm. per litre. of	Depth clear liquid, in mm., at end of				% at end of—				Remarks
pulp	5 min.	10 min.	15 min.	20 min.	5 min.	10 min.	15 min.	20 min.	
97	4*	7	10	15	1.06	1.85	2.65	3.90	H ₂ O only
97	250	331	338	313	61.19	88.70	89.70	90.60	168 gm. CaO
186	0*	12	16	...	0.90	3.19	4.25	...	H ₂ O only
186	131	216	280	292	31.80	65.40	74.20	77.40	168 gm. CaO
48.5	12	20	23	28	3.18	5.30	6.10	7.43	H ₂ O only
18.5	350	355	355	356	92.80	94.40	94.40	94.35	196 gm. CaO
170	23*	44*	68	85	6.11	11.70	18.00	22.50	H ₂ O only
420	37	69	98	125	9.80	18.30	25.30	33.20	84 gm. CaO

*Murky. In each case the tube was vertical, it had a diameter of 6 cm., and the depth of the pulp was 37.7 cm.

Screen tests.

+ 150 = 0.55%

+ 200 = 15.40

+ 200 = 84.05

TABLE II
SETTLING TESTS—WEST VEIN SULPHIDE

Depth of pulp cm.	Dilution gm. per litre of pulp	—Depth clear liquid, in mm., at end of—				V _u V _p % at end of —				Remarks
		5 min.	10 min.	15 min.	20 min.	5 min.	10 min.	15 min.	20 min.	
37.7	97	160	287	322	330	42.5	76.2	85.5	87.5	H ₂ O only
37.7	97	240	275	296	301	63.6	73.0	78.5	79.9	Trace CaO
37.7	97	200	254	269	277	53.1	67.4	71.4	73.5	196 gm. CaO per ton
37.7	186	82	150	217	259	21.7	39.8	57.6	68.6	H ₂ O only
37.7	186	77	127	165	193	20.4	33.7	43.7	51.1	Trace CaO
37.7	186	75	126	170	210	19.8	33.4	45.0	55.7	84 gm. CaO
34.2	48.5	232	316	318	320	82.5	92.5	93.0	93.5	H ₂ O only
34.2	48.5	247	281	285	289	72.5	82.3	83.5	84.5	448 gm. CaO
34.2	48.5	270	282	288	292	79.0	82.5	84.3	85.5	Trace CaO
37.7	420	9	16	22	32	2.39	4.24	5.84	8.49	H ₂ O only
37.7	420	12	19	28	36	3.18	5.05	7.44	9.56	Trace CaO
37.7	420	13	22	30	37	3.44	5.83	7.96	9.80	56 gm. CaO
37.7	390	14*	26	47	55	3.72	6.90	12.45	14.60	H ₂ O only
37.7	390	14	25	39	52	3.72	6.63	10.30	13.80	Trace CaO
37.7	390	7	16	27	37	1.85	4.24	7.15	9.84	924 gm. CaO

*Murky. In each case the tube was vertical and had a diameter of 6 cm.

Screen tests:

+ 150 = 0.50%

+ 200 = 14.90

— 200 = 84.60

TABLE III
SETTLING TESTS—MIXED SLIME*

Depth of pulp cm.	Dilution gm. per litre of pulp	—Depth clear liquid, in mm., at end of—				V _u V _p % at end of —				Remarks
		5 min.	10 min.	15 min.	20 min.	5 min.	10 min.	15 min.	20 min.	
37.7	97	186	315	327	330	49.3	83.6	86.9	87.5	H ₂ O only *
37.7	97	277	292	299	303	73.4	77.4	79.4	80.4	Traces CaO
37.7	97	210	258	288	299	55.8	68.5	76.4	78.3	1010 gm. CaO
37.7	186	121	194	255	273	32.1	51.6	67.6	73.5	H ₂ O only
37.7	186	77	128	167	199	20.4	34.0	44.3	52.9	252 gm. CaO
37.7	186	50	92	131	161	13.2	24.4	34.8	42.7	1030 gm. CaO
34.2	48.5	316	319	319	319	92.5	93.5	93.5	93.5	H ₂ O only
34.2	48.5	290	298	300	300	84.9	87.1	87.8	87.8	448 gm. CaO
34.2	48.5	271	291	295	296	79.4	85.0	86.4	86.6	1320 gm. CaO
34.2	420	15	29	43	58	4.40	8.49	12.60	17.00	H ₂ O only
34.2	420	16	25	38	52	4.70	7.30	11.10	15.20	140 gm. CaO
34.2	420	11	21	34	42	3.22	6.15	9.85	12.30	1000 gm. CaO

*Old West vein = 60%

San Carlos = 5

Sand dump = 10

Slime dump = 25

In each case the tube was vertical and had a diameter of 6 cubic centimetres.

were conducted both with and without an electrolyte, which with this slime produces a marked effect on the rate of settling.

I give another tabulation showing that the addition of lime has a marked retarding effect on the slime settlement, that is, the settling in pure water is more rapid than with the electrolyte. This is the only slime here (at El Oro) that exhibits this freak phenomenon. (See Table II.) When this slime is mixed with other slimes in the following proportions, the presence of lime has almost the same retarding effect as the slime alone.

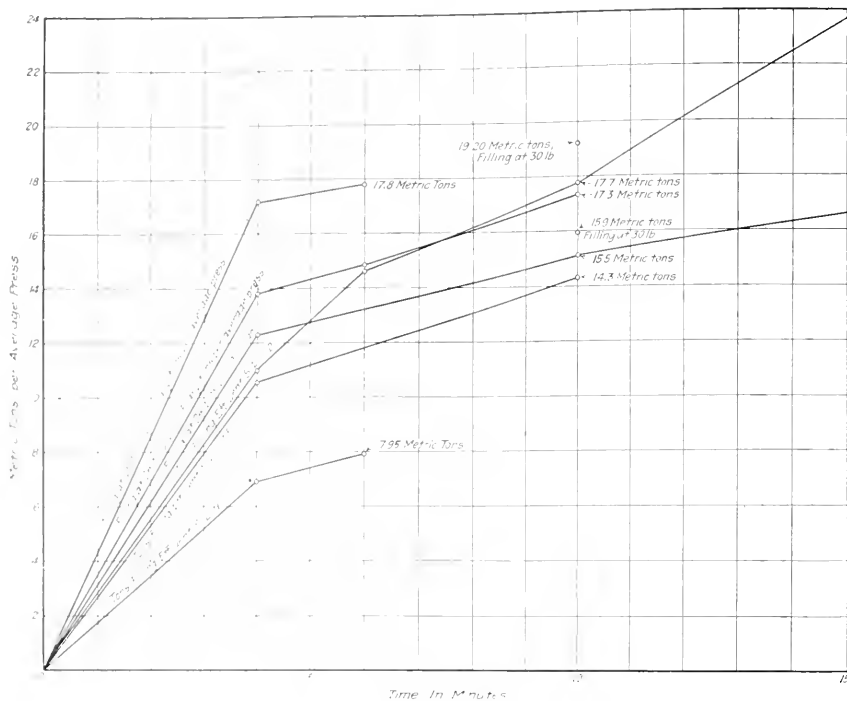
SLIME MIXTURE

	%		%
Old West vein-fill.....	60	Sand dump	10
San Carlos	5	Slime dump	25

It appears from the above that, other things being equal, the use of excessive alkalinity is a serious mistake.

Even with slimes that settle well with lime, an excess of the latter increases the viscosity of the solution, which in itself retards settling. This anyone can prove to his own satisfaction.

After the curves had been plotted, the points where they cut the 5% efficiency line were noted and these points were then placed in the settling scale (an arbitrary scale in the upper right-hand corner) to fix their settling number. For example, the San Carlos curve cuts the 5% efficiency line close to 400 gm. per litre, which corresponds to a settling number of 1. This number placed on the settling cross-section scale immediately below corresponds to one square foot per ton of dry slime. In this manner the approximate area of tankage was computed for certain mixtures of slimes expected in the daily routine of the plant. It will be seen, however, in studying the large curves that the majority



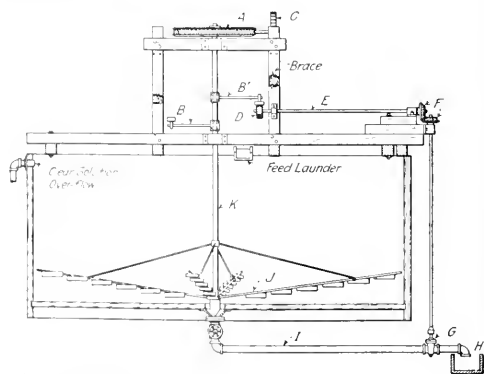
CURVE II. RELATION OF PULP-THICKENING AND FILLING-TIME.

metric tons. An increase in pressure of 1 lb., or a total of 30 lb., raises the tonnage per cycle to 19.2. In the case of the 1:2 pulp, with a pressure of 26 lb., the press will receive 15.15 tons, with conditions using the same and charging at 30 lb. the press will receive 15.9 tons. A change in our flow-sheet has enabled us to increase our filling pressure, which will no doubt be found advantageous when the plant is running again.

In order to approach the 1:1 pulp we decided upon intermittent discharge of the thickeners, in place of the continuous system. Intermittent discharge may be accomplished in several ways either by using some mechanical device for opening and closing the discharge-valves or with an electric mechanism giving an overload-alarm that rings when the rakes are plunging through a heavy charge of slime. This latter may be made automatic as well (Dorr electric automatic device) or it may be operated by an attendant, who, when warned, discharges the tank until the alarm stops ringing or an electric light goes out. The following is a sketch of the automatic rig for opening and closing the discharge-valves on all our thickener tanks.

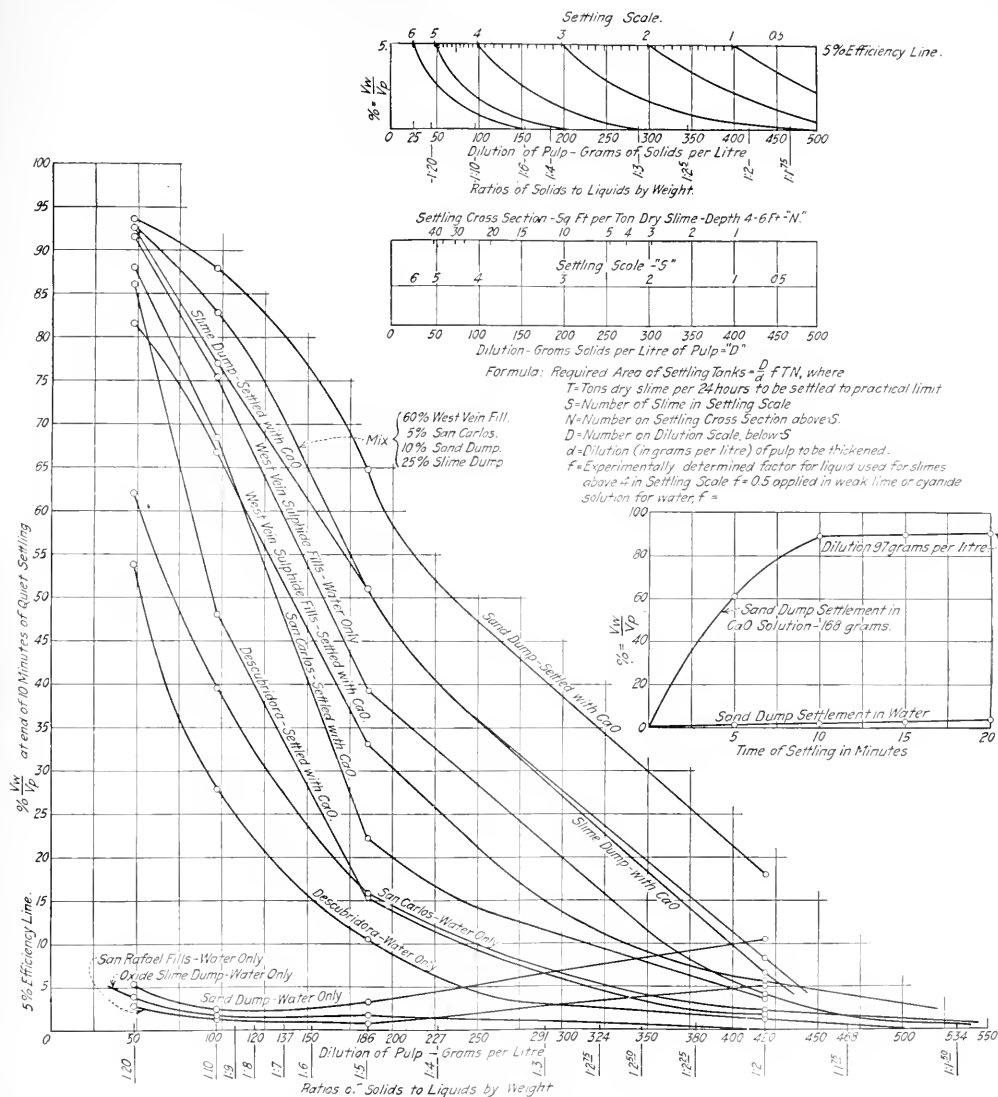
According to *The Mining Magazine*, the Anaconda has also designed an automatic opening and closing device for intermittent discharge; the Dorr Company furnishes an automatic device with their tanks if desired.

Our tests show that in order to obtain a 1:1 pulp, time must be allowed for the upper layers or zones of slime to



- A Worm-gear on Dorr tank.
- B-B' Arms with friction-clutches clamped to central shaft. One opens the valve and the other closes it.
- C Spur-gear.
- D Pulley keyed to shaft E. This pulley makes about a 90° turn in one direction when clutch C passes over and a 90° turn in the opposite direction when clutch C passes under.
- E Horizontal shaft.
- F Bevel-gears.
- G Plug-rock connected to vertical shaft.
- H Launder carrying thick pulp.
- I Discharge pipe connected to bottom of tank.
- J Rakes.
- K Vertical shaft.

Note Arms B and C should be set after determining experimentally the time required for settling and the time for discharge of the thickened pulp in order to secure the desired specific gravity of discharge.



CURVE I. SETTLING-RATIOS OF SLIMES FROM TABLES I, II, AND III.

flatten out toward the zero efficiency line at a dilution of 534 gm. per litre or a solid to liquid ratio of 1:1 $\frac{1}{2}$. This we found to be the case in actual practice. If special care was taken we could obtain pulp with a solid to liquid ratio of 1:1 $\frac{1}{2}$, but averages over weeks and months showed ratios close to 1 $\frac{3}{4}$:1. With such a pulp-feed from 20 to 30 minutes were required to charge the Merrill presses. After considerable work with a small filter-press and monteju equipment in our metallurgical laboratory, we found by thickening the pulp to 1:1 it was possible to charge in one-third the time (see Curve II). In this set of curves it will be noted that three degrees

of thickness of the slime were tried, namely, 1:1 $\frac{1}{2}$, and 1:2 (S : L). In four minutes of filling time a 1:1 pulp will charge (calculated from tests) the large filters with 16.2 dry metric tons; a 1:1 $\frac{1}{2}$ pulp, with 13.8 tons; and a 1:2 pulp with 12.2 tons. The gain in tonnage per cycle with the 1:1 pulp over the 1:2 pulp is 4.0 tons. With about 80 cycles per 24 hours the total gain will be 320 tons.

It may be interesting to call attention to the tonnage effect of increased pressure in filling (see Curve II). After 10 minutes' charging with 1:1 $\frac{1}{2}$ pulp at 26-lb. pressure, the average large filter will receive 17.3 dry

minge with the lowest, thus causing compression with a removal of interstitial fluid. As shown clearly by Clevenger and Coe, the degree of thickening in the compression zone is a function of time. This law was proved here in actual practice on a pyritic concentrate, 99% of which passed a 200-mesh screen. About 15 tons of this concentrate was ground daily in a special circuit of its own. It was necessary, on account of limited tank-capacity, to get this pulp as thick as possible. Continuous discharge gave a pulp of 1:3 solid to liquid ratio.

By closing the discharge-valve and allowing the tank to settle for as long as eight hours we secured a pulp with a moisture content as low as 45%. In cases like this an overload alarm would be the correct thing to use. The spring could be set to give the alarm when the rakes had picked up a pulp dry enough for discharge.

Concentration of Molybdenum

Treatment of molybdenite is not an easy problem, according to Herman Fleck of the Colorado School of Mines. Nearly everything has been tried of an ore-dressing nature on the molybdenum ores, no two of which are alike—and, on the whole, with surprisingly interesting results. Molybdenite is different from most minerals. It is heavy like a metallic sulphide and behaves in part like these, and then it is flexible, and not brittle, with strong basal cleavage and a tendency to flake like graphite or mica. Ordinary methods of concentration are hardly applicable. Complex ores, therefore, add to the metallurgist's troubles, and the physical condition of the molybdenite is another consideration. This is as follows: 1. coarse flaky pieces or particles; 2. fine flaky particles or grains; 3. both 1 and 2; and 4. thin flakes or filmy coverings.

The nature of the gangue material plays an important part. A filmy molybdenite deposited in seams of a hard quartz is an extreme example of refractoriness. A coarse-grained granite or pegmatite, carrying coarse mineral, is the other extreme. When associated minerals, pyrite, chalcopyrite, bismutite, native bismuth, claudonite, their oxidation products, or men and pyroxene, or perhaps several of these are present in either of the cases above, the problem becomes complex. However, combinations of heat, newer principles, such as flotation, magnetic and electrostatic separation, have done much to recover good concentrate from ore that was looked on unfavorably a few years ago. Only rarely does the mineral occur so coarsely divided that it may be hand picked.

Low native wages on the Rand has not resulted in notably low working costs, though the ratio of labor cost to total cost is somewhat below the probable average, according to H. F. Bain, who recently studied conditions in that region. Native efficiency is low, requiring highly paid supervision. One white man is paid more than 8 to 10 Kaffirs.

Output of the Disseminated-Copper Mines

Reports of the four porphyry copper companies for the third quarter of 1916 will soon be available, from which interesting abstracts will be obtained. Meanwhile a comparison of the yields for the first 9 months of 1916 and 1913 is worth study. These are as follows, in pounds:

	CHINO	
	1916	1913
January	5,316,975	3,440,274
February	4,617,220	4,018,789
March	6,333,255	4,602,809
April	4,496,270	4,046,813
May	6,359,294	4,067,486
June	7,243,618	3,876,533
July	6,883,403	4,893,325
August	6,326,116	6,650,867
September	7,397,204	4,435,873

	NEVADA CONSOLIDATED	
January	6,157,862	5,169,708
February	6,533,412	4,798,537
March	6,565,559	5,555,320
April	7,716,101	5,650,608
May	7,723,148	5,933,273
June	8,651,772	6,344,863
July	8,537,231	5,403,919
August	7,688,014	5,989,973
September	8,360,180	4,441,671

	RAY CONSOLIDATED	
January	4,263,440	3,869,006
February	5,767,087	4,007,918
March	6,379,581	4,422,872
April	6,294,033	4,514,565
May	6,278,611	4,405,217
June	6,598,594	4,392,612
July	6,834,492	2,526,000
August	6,697,032	4,401,566
September	6,250,937	4,470,551

	FRAN COPPER	
January	11,999,910	7,560,521
February	11,819,972	7,819,900
March	12,714,651	8,504,040
April	11,557,282	9,834,894
May	15,950,215	10,312,695
June	17,877,432	11,637,949
July	20,202,228	9,849,013
August	20,315,140	10,620,981
September	20,462,256	11,817,428

In several cases the monthly outputs in 1913 will be found equal to those in 1916, but the rate of production in November of the current year is far in advance, being practically the limit, until additional plant under construction is completed.

PALÉONTOLOGY is a highly specialized branch of geology, and many economic geologists have at most no more than a superficial knowledge of this science. When accurate determinations of fossils become necessary in order to fix the geological age of certain strata, such engineers and geologists usually submit the fossils they may have collected for this purpose to experienced paleontologists.

Two Washington Mining Districts

By Robert E. Brinsmade

INTRODUCTION. In opposite corners of the State of Washington there are two mining camps comparatively unknown to the outside world, in spite of considerable expenditures for development. The first, in the north-east corner, is that of Metaline Falls; the second, in the south-west corner, is that of Bald Mountain.

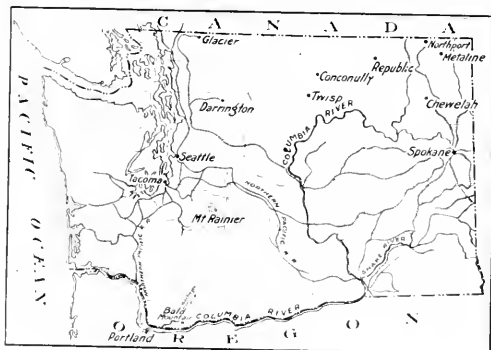
Metaline Falls is a town of 2000 people and is the terminus of the Idaho & Washington railway at a point 127 miles north of Spokane, and at an elevation of 2000 ft. above sea. The town lies on the east bank of the Coeur d'Alene river, which is the only stream of the district and forms the central feature of the mountainous landscape. The country-rock of the valley-bottom and adjoining cliffs is limestone, which rock, with some valley-clays, furnishes the raw material to the 1000-bbl. plant of the Inland Portland company at Metaline Falls. Of the metal mines, the only producer is the Larsen, but the Oriole, the Shellenberg, the Grandview, the Morning, and the Riverside are partly developed. Of these, only the first two lie on the west side of the river, and all save the Oriole are in the limestone formation.

THE LARSEN property follows some low hills on the west bank of the river. The first work at this mine was done some years ago by prospectors who sank a 45-ft. vertical shaft to a small zinc vein and then followed the vein down a short distance by an incline. When the property was re-opened last year, the old work was found to have been done on a branch vein and the recent output has been obtained from an open pit a hundred yards south. The open work has excavated the ore from the surface to the 50-ft. level, where the vein appears to be a fissure, 15 ft. wide, striking north and dipping 60° west. The vein has well-defined limestone walls, with a filling of quartz and calcite, showing a dissemination of small crystals of sphalerite of the resin-jack variety. Near the surface there appears white smithsonite, and small bunches of galena occur at intervals in the vein among the crystals of zinc.

The open pit is bounded on the south by a fault and extends 50 yards north. The broken ore, with little or no sorting, is drawn from the pit to the mill in trains of four 2500-lb. cars, by a Percheron horse over a tramway of 18-in. gauge and a quarter-mile long. To develop the vein below the pit-floor, the tramway has been extended north along the hillside to a new inclined shaft, which is being sunk on the vein about half-way between the south fault and the aforesaid prospector's shaft to the north. The new shaft has two compartments and is operated by an electric hoist. In fact, all the power for mine and mill is now supplied by wire from the hydro-electric

plant of the cement works at Metaline Falls, the current in use being 440 volts, 60 cycles, and 3 phases. For rock-drilling, hammer-drills are used, fed with air by a belt-driven compressor.

The mill-building is a wooden structure built in two parts on a hillside. The upper half contains the sorting-house and rests on a gentle slope whence there is a sharp drop for 50 ft. down a cliff to the washing-house at the foot of the hill above the wagon-road. In the sorting-house there is only a 9 by 14-in. Blake jaw-crusher, which discharges onto an 18-in. rubber sorting-belt 15 ft. long, whence the ore is spouted dry to the washing-house. Here the ore enters a Chalmers & Williams ball-mill, 6 ft. long, 5 ft. diam., running at 29 r.p.m., the discharge



MAP OF THE STATE OF WASHINGTON

being lifted by a rubber bucket-elevator and divided for screening to 14-mesh between a 3 by 6-ft. trommel and a Wood revolving conical screen. The screen-oversize returns to the ball-mill, while the undersize is dewatered by an inclined drag-conveyor made of angle-iron scrapers bolted to a 10-in. rubber belt. This last discharges the dewatered pulp into a rising-current classifier. Five classifier-spigots each feed an Overstrom sand-table, each of which produces a lead heading, a zinc middling, and a tailing that descends to the settling-pond. The classifier-overflow runs to two 9-ft. Callow cones, the settling from which is treated on 11 Overstrom slime-tables; these last yielding the same lead and zinc products as the sand-tables, and a tailing that accompanies the overflow of the Callow cones to the settling pond. The lead heading and zinc middling of the Overstroms are both shipping products and they fall to wooden bins on the lowest level. Here, after drainage, they are shoveled into steel Koppel self-dumping boxes mounted on four-wheel wagons, which are hauled by horses to the gasoline motor ferry at the town of Metaline, and transferred to the

*Consulting engineer, Puebla City, Mexico.

railroad box-cars, waiting across the river at Metaline Falls, to be taken to the Missouri smelters. The zinc concentrate assays 50 to 54% zinc; this leaves a good profit at present, in spite of the high freightage of about \$12 per ton. The lead concentrate is only 10% of the shipment and is thus insignificant in quantity. The mill was started in August 1915, and has since then been handling 2500 to 2800 tons per month of crude ore assaying 8 to 14% zinc. It is planned later to erect a flotation plant to re-treat the tailing now being stored in the settling-pond.

THE ORIOLE mine is two miles north-west of Metaline, and is owned by the Metaline Oriole company of Spokane. The mine is situated on the east side of a gulch running north into the quartzite hills on the west side of the limestone valley of the Pend d'Oreille river. An adit has followed the vein eastward for 880 ft. and midway is connected by an incline-shaft with the surface. The vein is a fissure 1 to 6 ft. wide, it dips 50° north, and is filled with quartz containing galena, sphalerite, pyrite, and chalcopryrite. The sorted ore runs 35% each of zinc and lead, 30 oz. of silver, and a little copper. Such a composition means a hard nut for the smelter and necessitates some sort of separation at the mine before shipment.

SHELLENBERG. The development here consists of a number of shallow shafts or pits on the top of a 300-ft. bluff east of the river and a mile north of Metaline Falls. The outcrops opened by the pits show quartz pockets, up to 30 ft. long and 20 ft. wide, with a sprinkling of galena nodules. The ore on the dump runs from 20 to 60% lead, but, like all the galena of this district, it is poor in silver, containing only 2 or 3 oz. per ton.

GRANDVIEW. This prospect lies on the bluff north of the Shellenberg, and is developed by two adits driven east into the face of the cliff above the river. The first adit discovers nothing in its 50 ft. of length, but the other adit cuts a cross fissure at 75 ft. from its mouth, and by a stope driven upward, farther in, reveals a clay-like filling interspersed with large boulders of quartz and galena.

MORNING. This property is opened by a 100-ft. vertical shaft placed 100 ft. above the river and three miles north of Metaline Falls. Besides two adits almost a mile of underground cross cutting and driving has been done from the shaft at the 80 ft., 200 ft., and 400 ft. levels. This work has been done with a view to exploring in depth the outcrops of galena, but so far the mine has not become a shipper. Besides the hoisting house, office, and bunk house, there is a complete equipment of machinery. A horizontal return tubular boiler of 80 hp. supplies steam for the second motion single drum hoist, which handles the ore bucket, and for a 5-drum straight line compressor, which supplies air for drills and pumps. The 400 ft. level is more than 200 ft. below the level of the river, and the seepage is from 60 to 100 gallons per minute, according to the season.

RIVERBANK. This ground lies four miles north of the Morning mine and is opened by an adit driven into a

300-ft. limestone cliff on the east side of the river, at a point about half-way to the top. At the mouth of the adit there is an outcrop of iron ore showing bunches of galena, but this was soon penetrated, when opened a few years ago, and as no more ore could be discovered, the mine was shut-down.

THE BALD MOUNTAIN district is in Skamania county, near the north bank of the Columbia river. The railroad station is Cape Horn, on the Great Northern system and only 30 miles north-east of Portland, Oregon. The mineral zone lies in the foothills of Mt. St. Helena, a prominent peak in the western Cascades. Unlike the Metaline Falls region, this district, as far as observed, shows only igneous rock, covered by a cap of lava of the basaltic type. The topography, though bold, is rounded and well adapted to the growth of huge firs and other conifers, which densely covered much of this country as late as 20 years ago, but which has recently been decimated by forest-fires and the woodman's ax. To reach the mines one must climb the hills north of Cape Horn for a distance of 20 miles horizontally and over 1500 ft. vertically. The best wagon-road follows the gulch of the Washougal river and occasionally changes from one bank to the other over plank-bridges often supported by single spans of huge logs. As one ascends into the hills, signs of extensive and reckless lumbering appear in the forest: not only have the bulk of the trees been killed by fires, but huge sound logs everywhere strew the ground as they were left to rot by the careless cutters. At intervals appear crib-dams that served to supply the artificial floods necessary for floating the logs down-stream to the Columbia river.

The mineral zone is being developed by three companies: the Washougal Copper & Gold Development, the Skamania, and the Washougal Gold & Copper. The mines lie within the space of a league and the workings delve into hills of brown andesite from the vantage-points offered by narrow gulches with high steep sides.

WASHOUGAL COPPER & GOLD DEVELOPMENT Co. This property is the least developed of all, [despite its name, *Error*] having only a 400-ft. adit, but the large expenditure incurred this summer for the repair of the wagon-road to Cape Horn indicates a renewal of activity.

SKAMANIA. This ground is opened by a 1300-ft. adit and a connecting shaft 575 ft. deep. Shipments have been made to the Tacoma smelter, and some recent assays of sorted ore gave the following results:

Lot Number	Copper %	Silver oz.	Gold oz.
1	18.2	15.2	0.02
2	23.5	13.4	0.01
3	15.8	8.7	0.01
4	21.6	18.5	0.02
5	19.4	15.6	0.18

WASHOUGAL Gold & Copper Mining Co. This is the most extensively developed mine of the district and the only one having a mill. Here are two parallel veins on opposite sides of the narrow gulch of Shirt creek, a branch of the Washougal river. Each vein dips about 70° into the hillside and follows closely the westerly

course of the gulch. The veins are strong fissures varying in width from one to six feet but the filling, save in the shoots or chimneys, is only barren country-rock. These chimneys are of quartz, they vary in length from 20 to 40 ft., and contain chalcopryrite, bornite, and sphalerite disseminated in bands of minute dispersed crystals. The sorted ore resembles, in the ratio of its content, the assays given for the Skamania mine, having about 1 oz. of silver to 1% of copper, but each unit of copper is here accompanied by $1\frac{1}{2}$ units of zinc.

Each vein is entered by a main adit from the bottom of the gulch, started at 1700 elevation or some 400 ft. below the outcrop. The north, or Dixie, vein is cut by a 400-ft. adit, and is then followed to the west for 1200 ft. by a drift. At the north end of the adit is a 130-ft. incline-shaft. No underground communication yet exists with an upper adit and drift that explore the vein at 1850 ft. elevation. The south, or Copper King, vein is also cut by a 400-ft. adit, but here the chimneys are more frequent, so that the drift has been extended west for over 2000 ft. along the vein. Near the west end an incline-shaft has followed the vein down for 130 ft. and opened up the best ore in the mine.

This property is fully equipped with buildings and machinery. There is an office, a cook-house, and several bunk-houses, as well as the mill and repair-shops, all placed in the gulch below the main adits. Power for the mine is furnished by a 36-in. Pelton wheel, which takes its water, under 365 ft. head, from a wooden flume heading in Shirt creek. As the snow falls here to a depth exceeding 10 ft., there is plenty of water for power except during the summer, when steam-power is used. Drilling is done by hammer and piston drills supplied, like the mine-hoists and pumps, by an Ingersoll-Rand belt-driven compressor of No. 10 type and of size 12 by 12 by $7\frac{1}{2}$ by 12 in. For cutting cordwood for the three boilers, aggregating 140 h.p., and ripping boards for the buildings, there is a small saw-mill that is fed by logs hauled directly from the forest-clad hillsides by a steam-winch.

The concentrating mill is yet in the experimental stage, the product being low in copper, and the tailing rich. The flotation process will have to be tried. There are now installed a 7 by 10-in. Blake jaw-crusher, two Nissen stamps, a Pierce amalgamator, a cone-classifier, a Wilfley table, and a Frue vanner, all actuated by a 10 by 14-in. horizontal steam-engine. The silver of the ore will not amalgamate, but laboratory tests have shown that it can be saved, along with the copper and zinc minerals, by flotation.

THE MINING BUREAU of the Japanese Department of Agriculture and Commerce has decided to institute researches for mineral deposits throughout that country, and will ask for the appropriation of 88,000 yen (1 yen = 50 cents) to be included in the budget for the fiscal year of 1917. Of the amount, 32,000 yen is said to be appropriated for carrying on a geological survey of principal oilfields.

Phosphate Rock Mining

*Reserves of phosphate in the United States are estimated as follows, in long tons:

Eastern States:

Florida	227,000,000
Tennessee	88,000,000
South Carolina	9,000,000
Kentucky	1,000,000
Arkansas	20,000,000
	<hr/> 345,000,000

Western States:

Montana, Idaho, Utah, and Wyoming.....5,367,982,000

Total5,712,082,000

During 1915 there was marketed 1,835,667 tons, valued at \$5,413,449. This was a decrease of 33% in



MAP SHOWING PHOSPHATE ROCK DEPOSITS OF THE UNITED STATES.

quantity and 44% in value compared with 1914. The War was responsible for this, restricting exports. The total quantity mined was 1,358,611 tons in Florida, 389,759 tons in Tennessee, 83,460 tons in South Carolina, and only 3837 tons from Idaho, Utah, and Wyoming.

Exports amounted to 253,549 tons, worth \$6.33 per ton, a decrease of 710,565 tons. From 1905 to 1915, exports of phosphate rock were 40% of the total 50,293,573 tons mined. The highest grade shipped contains 77% calcium phosphate, with 3% or less of iron oxide and alumina.

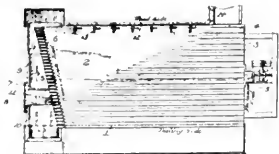
Simple field tests for phosphates are given by W. B. Hicks. The best method is to moisten the fresh rock surface with a drop of nitric acid, and then place a small crystal of ammonium molybdate on the moist spot. A yellow color indicates the presence of small quantities of phosphates.

BARK should always be removed from timbers before placing them in the mine. There is no economy in placing timbers in any mine, wet or dry, from which the bark has not first been removed. Insects work rapidly between the bark and the wood and a good-sized timber is soon rendered worthless through decay.

*Abstract from U. S. Geological Survey bulletin, by W. C. Phalen.

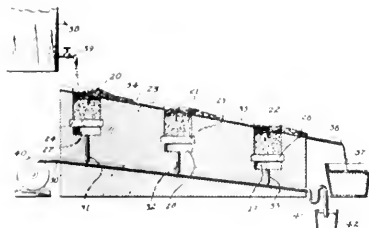
RECENT PATENTS

1,197,598. CONCENTRATING TABLE. Robert H. Richards, Boston, Mass. Filed May 6, 1913. Serial No 765,915.



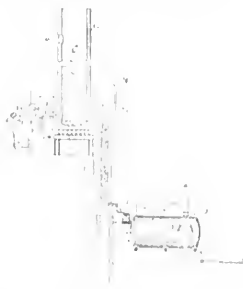
1. The combination of a laterally inclined, longitudinally shaking concentrating table adapted to deliver the concentrated product over the end edge thereof; guiding means on the discharge end of said table, extending substantially the entire depth of said end edge to guide the concentrated product during discharge, and a divider structure for receiving material discharged from said guiding means and for maintaining the classification thereof.

1,198,519. METHOD OF TREATING LIQUIDS WITH GASES. Charles S. Bradley, New York, N. Y. Filed Dec. 18, 1913. Serial No. 897,537.



1. The method of producing chemical action between a gas and a liquid, which comprises introducing into the liquid a gas which is chemically active with respect thereto, to produce a foam and discharging only the foam therefrom as the product.

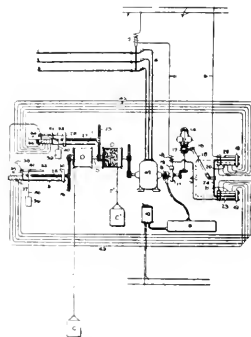
1,198,134. COPPER-REFINING FLASKS. A. Garder, New York, N. Y. Filed Apr. 26, 1916. Serial No. 93,728.



1. In the refining of copper, the flask consisting of a chamber in the center through a cupola furnace, adapted to receive the molten metal, and a series of flaps or partitions adapted to receive the molten metal and to guide the charge in the heat of the furnace, pos-

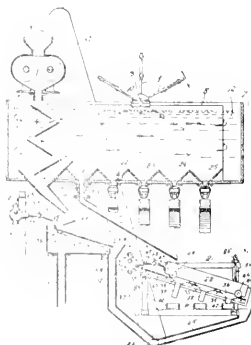
ing the flapped molten metal over solid carbonaceous material to partially pole the metal, conducting the partially poled metal to a suitable poling furnace, blowing the molten metal in said furnace with air to effect any desired oxidation, and finally blowing the charge with non-oxidizing gas charged with finely divided carbon particles to complete the poling.

1,200,264. ELECTRICALLY-OPERATED HOIST. Fred L. Stone, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed Sept. 14, 1914. Serial No. 861,504.



1. The combination with the motor of an electric hoist, of means for gradually varying the speed of said motor between certain points in the travel of the hoist, comprising a controller, a speed responsive device actuating the same to various positions, a second controller actuated by the hoist, and connections between the controllers for effecting the control when the controllers are not in corresponding positions.

1,198,491. DEWATERING AND SCREENING APPARATUS. James B. Ballantine, Silver Plume, Colo., assignor of one-half to William B. Robeson, Port Huron, Mich. Filed Oct. 5, 1915. Serial No. 51,139.



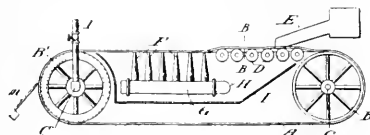
The combination of a crushing means, a hydraulic classifier receiving from the crushing means and adapted to subdivide the material into a series of classes, a draining device adapted to receive the material of the coarsest grade and drain the

same, a draining and screening device adapted to receive an intermediate grade from the classifier and to drain and size the material of said grade, and means for returning the material of the draining device and oversize material from the draining and screening device to the crushing means.

1,200,334. PROCESS FOR THE PRODUCTION OF NITRIC ACID FROM NITROUS GASES. Antonius Foss, Christiania, Norway, assignor to Norsk Hydro-Elektrisk Kvaestowaktieselskab, Christiania, Norway. Filed Feb. 23, 1915. Serial No. 10,071.

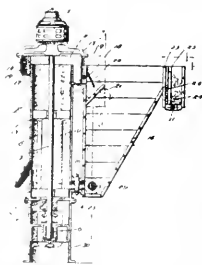
1. In the utilization of nitrous gases, the process which comprises absorbing said gases in alkali, decomposing the resulting alkali metal nitrogen compounds by suitable decomposing agents to liberate nitrous acid gas in a more concentrated form, recovering the alkali for the absorption of fresh quantities of gases, and recovering and returning the decomposing agents into the cycle of operations.

1,201,021. FILTERING-BELT. John M. Callow, Salt Lake City, Utah, assignor to The General Engineering Company, Salt Lake City, Utah, a Corporation of Utah. Filed Mar. 4, 1916. Serial No. 82,186.



1. In a filtering machine, the combination with an endless traveling filtering belt and means for separating thereon, the liquid from the solid constituent of a solution to be filtered, of pneumatic devices for removing the caked material from the surface of the belt by exhaustion.

1,201,053. ORE-CONCENTRATING APPARATUS. Thomas A. Janney, Garfield, Utah. Filed Apr. 23, 1914. Serial No. 833,973.

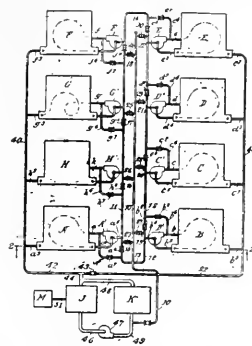


1. In a concentrating apparatus, an agitation vessel and separating box communicating with each other through upper and lower ports, and agitating and impelling means in said vessel for agitating an ore pulp therein and adapted to move all of said pulp from said vessel into said box and to move the pulp in a circuit through one of said ports to said box and back through the other port of said vessel, said box having an overflow lip below the level of said upper port.

1,200,534. PROCESS OF RECOVERING COPPER FROM SOLUTION. George A. Schroter, Denver, Colo., and William C. Laughlin, Nogales, Ariz. Filed Apr. 29, 1915. Serial No. 24,640.

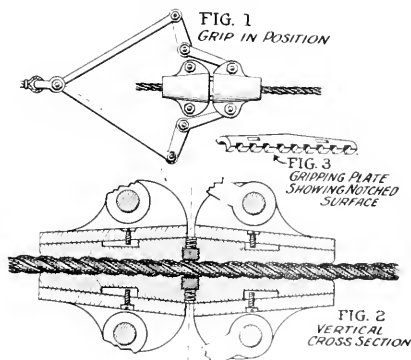
The process of recovering copper from solution which consists in adding calcium hydroxid in solution thereto, filtering same, roasting or calcining the precipitate to render the iron inert, adding sulfuric acid to the precipitate and filtering the copper solution.

1,200,832. APPARATUS FOR EXTRACTING METALS FROM THEIR ORES. John C. Greenway, Warren, Ariz. Filed Mar. 31, 1915. Serial No. 18,289.



1. An apparatus for extracting metal from its ores comprising a series of leaching tanks adapted to contain the ore, a circulating pump for each tank having its inlet and outlet connected to said tank for circulating leaching solution in each tank, means for advancing the solution from each tank to the succeeding tank, means for supplying solution to the first tank of the series, and means for withdrawing solution from the last tank of the series.

1,192,065. CABLE-GRIP. Vilas H. Jackson, Cleveland, Ohio. Filed Nov. 3, 1915. Serial No. 59,413.



1. A cable-grip including a plurality of gripping jaws each having its outer face inclined, opposed relatively slidable elements engaged upon the inclined faces of the jaws, operating connections between said elements, and means connected to said operating connections to actuate the same and simultaneously shift said elements upon the relatively stationary jaws to force the jaws into gripping engagement upon a cable arranged between the same.

1,201,301. PROCESS OF MAKING EMULSION AND PRODUCTS THEREOF. Henry Hicks Hurt, assignor to Robeson Process Company, New York, N. Y. Filed Jan. 27, 1916. Serial No. 74,687.

1. The process of making permanent emulsions of oils and sulfite waste liquor preparations which comprises thoroughly intermingling such a preparation and such an oil and after the mingling is complete adding a small amount of caustic soda.

2. The process of making permanent emulsions of drying oils and sulfite waste liquor preparations which comprises thoroughly intermingling such a preparation and such an oil and after the mingling is complete adding a small amount of caustic soda.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

CRIPPLE CREEK, COLORADO

GOLD YIELD—VINDICATOR FLOTATION PLANT.—DRAINAGE-TUNNEL.

The gold output from the Cripple Creek district for October is reported by the mills and smelters as follows:

	Tons	Average value	Gross value
Golden Cycle, Colorado City	237,000	\$18.00	\$666,000
Portland, Colorado Springs	19,378	20.16	221,316
Portland, Cripple Creek	19,700	2.62	51,614
Smelters—Denver and Pueblo	1,500	55.00	247,500
Isabella mill	2,100	2.90	6,950
Worcester-Ruble mill	1,200	2.50	3,000
Total	275,778	\$15.79	\$1,196,390

The 250-ton flotation plant of the Vindicator Consolidated started operating a week ago. If the results are as satisfactory as anticipated, steps will immediately be taken to enlarge the capacity.

Work in the Roosevelt drainage-tunnel has been temporarily suspended, on account of the shut-down of the Elkton main shaft. Re-timbering of the shaft down to the 200-ft. level is under way, and as soon as this is completed, work will be resumed in the heading of the tunnel.

FLAT RIVER, MISSOURI

CONDITIONS IN THE LEAD DISTRICT—ST. LOUIS COMPANY BUYS LAND—NEW MILL OF FEDERAL LEAD, DOE RUN POWER PLANT—FREDERICKTOWN DISTRICT.

During the past few months this district has prospered under the high price of lead. For a time the market showed a tendency to decline, but about the middle of August quotations became strong and remained so since. All of the companies are operating to full capacity of the boilers, and a record output of lead is being made. There are no indications of labor troubles, the men being satisfied with their wages, which are higher than ever before. The companies are investing in properties and plants. Drilling, both on prospect and development, has been pushed all the summer.

The St. Louis Smelting & Refining Co. has recently bought the 100-acre tract just south of Elkton, consisting of 620 acres, the purchase price was \$165,000. It had already purchased the E. W. Hill tract between Bonne Terre and Deleville, consisting of less than a quarter section, for which was paid \$60,000.

The new mill of the Federal Lead Co. at Elkton, bearing on both sides the machinery, flatter and longer, being in place. The building is a work of art, the first of its kind, being entirely of concrete and steel. Its location was carefully watched with interest at every development of drilling in this district has been utilized in the new plant.

The new power plant of the Doe Run Lead Co. at River View, on the river, is completing, the addition of its 100-hp. Stirling engine, intended to produce power.

The Foster Elvins company, a new corporation, at Flat River, now owning a mine south of Elkton.

The Fredericktown district is prospering on a scale never known at any time since the early days of 1917. The Missouri Lead Co. has taken over the North American property, and is re-modeling the plant, both running and mill, and is expected to be ready to lead this company to make a record output.

TORONTO, ONTARIO

PORCUPINE, KIRKLAND LAKE, AND COBALT NEWS.—WATER-POWER INVESTIGATION.

A party of 25 Canadian and American capitalists, mining engineers, and others, including Gordon Crean, president, and E. A. Snowman, one of the directors of the Davidson mine, Porcupine, left Toronto on October 24 to make an inspection of that property returning on the 29th. The visitors were much impressed with the value and extent of the free gold exposed, the finest of which is seen in an extension of the main vein 400 ft. north of the shaft, where an open-cut has been made 10 ft. deep and 25 ft. wide, which yielded some rich ore. The main shaft is down 315 ft., and the cross-cut on the 300-ft. level is in 60 ft. towards the vein. Much lateral development has been done on the 100 and 200-ft. levels, and a large body of ore has been developed.

At the Dome Lake the Hardinge ball-mill has been installed and operations will shortly be resumed. The capacity of the enlarged mill is 200 tons per day. Underground development has opened some good ore-shoots and some high-grade ore has been broken in the stopes in the 300 and 400-ft. levels. The shaft will be sunk to 700 feet.

The shaft of the Porcupine Crown has reached a depth of 900 ft. on the main vein, at which level the ore is of good grade. Diamond-drilling to pick up parallel veins is being carried on from the 500-ft. level.

The Inspiration, a recently organized company, the property of which adjoins the Hollinger Consolidated, is about to begin diamond-drilling with the object of finding extensions of the Hollinger veins. H. W. Darling has been appointed consulting engineer.

Another important discovery has been made on the Neway, a new vein having been found near the Plenaurum and stripped for 30 feet.

At the McKane property, Kirkland Lake, the vein on the 300-ft. level is proving much wider than at first. The width is now given at 15 ft., the ore assaying \$9.25 per ton. Ore reserves are valued at \$500,000.

The Lake Shore, Kirkland Lake, has installed a 7-drill compressor and other machinery, and will operate with steam power until electricity is obtainable from Cobalt.

The Nipissing has increased its ore reserves by 1,000,000 oz., by opening a remarkably wide shoot on No. 490 vein. This was cut on the level driven from a winze at a depth of 135 ft., and shows 8 in. of high-grade ore. It is stated that there are indications of other good veins in the immediate vicinity. The Nipissing management has closed an important contract for the handling of its by-products, the principal of which is cobalt, for which there is an increased demand in the manufacture of chrome-nickel steel. The financial statement as of October 2, showed cash on hand and bullion to the amount of \$2,228,110, being the best position in the company's history.

At the Crown Reserve a new vein 3 in. wide has been found on the 290-ft. level. It has been driven on for 35 ft., and in places yielded 2000 oz. per ton.

The Foster Elvins have cut several veins on the 1600-ft. level at the lower contact which contains cobalt, nickel, and some silver.

Samplings of the Little Nipissing on behalf of Detroit and Toronto interests, who have leased the property, is stated to

have given satisfactory results. A company will be formed to operate the property.

Cross-cutting from the lower level of the People's has reached the large vein which crosses that property and the Ophir. It is 8 in. wide and somewhat mineralized.

The Calumet & Montana Consolidated has cut a vein in the east drift at the 60-ft. level.

The Belle Ellen of South Lorrain has taken its place in the list of shipping mines. A consignment of 70,059 lb. of ore of good grade was recently dispatched.

Investigations made by the Canadian Department of the Interior indicate the great possibilities existing for water-power development. It is estimated that 17,746,000 hp. is available, not including the northern territories and outlying portions of Quebec and the Yukon. The power so far developed aggregates 1,712,193 hp. of which Ontario has 789,466, Quebec 520,000, and British Columbia 265,345. Eight million horse-power of the available undeveloped water is within the range of present markets, and will be in use within the next 15 years, according to official estimates.

In the first half of the current year the production of nickel in Ontario was 42% greater than for the corresponding period of last year, according to the report of the Ontario Bureau of Mines issued a short time ago. It is probable that the output and value will be greater also during the last half of the year. Early in 1916 the smelting and refining capacity for Ontario ore will be larger, as additions are being made to that in the United States and England, and new plants are in course of erection in Canada.

JARBIDGE, NEVADA

REVIEW OF CURRENT DEVELOPMENT WORK.

It may be said that the conditions in the Jarbidge district during the past summer have been good and developments favorable. In the early spring, the Starlight, a prospect, through the efforts of N. M. Muir and R. N. Hill, was optioned, and development work carried on by W. P. Hammon of San Francisco, under the direction of E. A. Haggott. Later in the summer, through the efforts of N. M. Muir and A. F. Peery, the Flaxie mine and the Jarbidge Gold properties were optioned, and are now under development by the Hanford interests of San Francisco. These two properties adjoin the Starlight on the north. The Hammon people were offered an attractive advance on their holdings on the Starlight by Hanford, which was accepted, and the development of the three properties, under one management, has been proceeding rapidly. The Hanford syndicate also had several smaller prospects in the district under consideration, which it has now dropped, and is concentrating all of the work on the Starlight-Flaxie-Jarbidge Gold group. The work is under the direction of N. M. Muir, formerly of San Francisco. Development on the Starlight consists of three adits: two of these adits, No. 1 and 2, being the upper ones that have encountered the vein, which has been opened for 350 ft. on No. 2 and for 150 ft. on No. 1 adit. Winzes and raises from these two levels have proved a continuity of ore vertically, at present giving a depth of 250 ft. It is understood that this ore will average over \$15 per ton. About 30 men are employed at the Starlight. The Flaxie mine had considerable work done on it by the original owners, the Flaxie Mines Co., and under the present management new development has been vigorously pushed to the north, through No. 1 adit. It is understood that \$12 ore has been opened in the property, and prospects are encouraging. There are 10 men employed. The Jarbidge Gold is in a good situation, adjacent to the Flaxie and Starlight on the south and the Long Hike on the north. A long cross-cut adit is being driven to cut several veins that are supposed to exist in this ground. Ten men are employed. With the Starlight and Flaxie there are 50 men being employed by the Hanford interests, in a very vigorous campaign.

The Long Hike property is generally understood to be of

large possibilities. The mine is developed by four adits, all of which have cut the vein, and showing a shoot some 800 ft. long. A considerable amount of machinery and equipment is being installed by the Long Hike, such as a semi-diesel plant and generator for a central electric plant, to furnish power for electric hoists in the mine, and electric exhaust fans and diamond-drills. A hoist and skip-way is being installed to take material from the creek level to the mine. Some 75 men are employed under the direction of E. A. Austin. The Long Hike interests are also developing the O. K. property on Bourne gulch. Thirty men are at work there. The Long Hike people are also developing the Alpha, adjacent to the O. K., and have been milling the ore from the O. K., that has been taken out in development, with a five-stamp mill on the Alpha. It is understood that the extraction has been fairly satisfactory.

The I. A. Anderson syndicate, of Spokane, Washington, has optioned and started work on several likely prospects, among them the Kiyi, Swasteka, and National groups. J. T. Macauley is superintendent of this work.

The year 1916 has shown a marked revival in the old-new camp of Jarbidge, and there is a population of 600 or 700 people in the district. A vigorous development campaign is anticipated for the winter, and larger things for next summer. Developments have been interesting, owing to the fact that all of the veins are fissures in rhyolite, it being one of the few districts where there has been such a marked continuity of veins in rhyolite. The underlying geological formations are sedimentaries, and two distinct rhyolite flows cover the country for many miles in extent. The vein systems carry in the second or younger rhyolite. Few of the strong ore-bearing veins outcrop on the surface, the only indication of their whereabouts being pinnings in the surface wash—the two exceptions to this being the large quartz outcrop of the Pick and Shovel vein and the Bourne vein. The proving of these veins in depth will be a valuable and interesting addition to geological information as to veins in rhyolite.

SUTTER CREEK, CALIFORNIA

RESUMPTION OF MINING AND MILLING.—OLD EUREKA.

The Mother Lode towns recently affected by the strike are gradually getting back to normal conditions. Teams and trucks carrying timber and supplies to the mines and concentrate from the mills are again on the road. The Bunker Hill mill resumed crushing at half capacity last Wednesday, and the same day the South Eureka mill started 20 of its 80 stamps. The South Eureka had 80 men on its pay-roll the day after the strike was declared off, about half of whom were strike-breakers from outside districts. The force is being increased daily, and it will not be long before the company is employing its usual complement, 250 men. The Bunker Hill men were the first to return to work, 30 returning before the end of the strike and 60 being at work during the week. As an official of that company, expressed it, "we don't know whether our men were on strike or not, for we laid them off a day or two before so as to do repair work in the shaft, and took a number back before the Union allowed its members to return." As the men apply for work, in most instances the companies are taking them back. The Treasure mine has resumed in full force. The Argonaut and Kennedy employees are slower in accepting their old jobs, although those mines are steadily increasing their crews; many of the men still feel that mines paying so well should not have held out against the Union's demands.

The work of unwatering the Old Eureka mine is proceeding most satisfactorily, the 900-ft. station having been reached with a space of clear shaft below, showing that the timbermen will not have to contend with caves for a while, as they did below the 800-ft. level. About 55 men are employed, the majority of whom are engaged in erecting the steel head-frame and making sundry surface improvements.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JENSEN. September yields of the mines on Douglas island were as follows:

	Alaska Mexican	Alaska Treadwell	Alaska United
Stocks of broken ore in mine, decrease or increase, tons, . . .	19,550	11,199	+14,838
Stamps dropping	120	150	300
Days	17.37	29.75	29.54
Ore crushed, tons	10,780	21,791	48,069
Average yield per ton	\$1.53	\$2.19	\$1.80
Gold from all sources	\$16,545	\$54,249	\$86,546
Operating expenses	12,261	31,140	39,312
Profit	1,119	22,567	.....
Construction	3,109	11,781	21,629
Net profit	1,910	10,786	.....
Loss . . . . .	.....	.....	35,261
Other Income	3,730	11,281	3,730
Value of copper plates	26,035	42,289	.....

During October the Alaska Gold Mines treated 158,000 tons of ore assaying \$1.32 per ton. Returns for the current year are as under:

Month	Tons	Value	Recovery, %
October	158,000	\$1.32	82.49
September	135,760	1.30	82.91
August	169,000	1.38	81.51
July	159,103	1.24	80.64
June	164,800	1.08	79.25
May	175,215	1.40	82.85
April	165,939	0.94	78.71
March	162,796	1.03	77.47
February	122,858	1.02	.....
January	114,183	1.12	.....

KENNICOLL. The October copper output of the Bonanza mine was 7,300,000 lb., compared with 8,000,000 in September, and an average of over 10,000,000 for the previous 10 months.



REPRODUCED FROM MAP OF YUKON TERRITORY, ALASKA, SHOWING POSITIONS OF KEY TOWNS.

NOVEMBER. The Alsea Mines Corporation has purchased through the Yuba Construction Company of California the largest bucket line ever made. This contract has been given to the Taylor-Wenton Company of Honolulu, N. O. to erect and install the bucket line and related equipment. It is to be made of man-

ganese steel, and installed on the new dredge which will dig 60 ft. below water. This dredge is working on one of the other properties of the company at Nome.

ARIZONA

On November 14 the third annual mine-rescue and first-aid contest was held at Phoenix. Competitors were the Old Dominion, Detroit, Copper Queen, Calumet & Arizona, and Ray Consolidated teams. The prizes are \$100, \$75, and \$25 cash for three places in each of the two contests. The Southwestern Mine Safety Association is in charge of the meeting, J. T. Moore, secretary. Bulletin No. 38 of the State Bureau of Mines is entitled 'State Safety News.'

CHINO. The electric transmission-line reached this place on the 5th. A transformer-station is now being built.

The Elkhart mine has been taken over by W. L. Leland and San Francisco people. A shaft is to be sunk 1000 ft., and the mill re-modeled.

There has been a large influx of people to Chloride, making accommodation difficult to secure. Many buildings are being erected.

HAYDEN. Considerable development is under way at the Gila Canyon Consolidated, 4 miles north. Returns are improving, the last car of ore averaging 6.53% copper, netting \$20.28 per ton.

JEROME. Accommodation here is said to be at a premium, owing to the number of people being attracted by the boom.

The United Verde Extension company states that eight raises have holed through to the 1300-ft. level from that at 1400 ft., and between these levels there is 700,000 tons of ore. The average is 16% copper. Over 300 ft. of drifts have been driven at 1300 ft. A winze below 1400 ft., after passing through 114 ft. of 15% ore and 46 ft. of low-grade ore, encountered at 160 ft., one of the bars of intrusive waste characteristic of the deposit. Sinking continues. On November 1 a dividend of 50c. per share was paid.

MIAMI. Just over 500,000 tons of ore was hoisted by the Inspiration during October, one day's output being 21,300 tons. Additional motors were installed in the crushing-plant. Owing to an armature burning-out in one of the motors of the generator set, control is by hand, instead of the automatic arrangement. This trouble has since been remedied.

OVAN. It is rumored that the Tom Reed company is to erect a 500-ton mill, in place of its present plant.

ARKANSAS

Zinc ore production, mostly calamine, of the northern part of the State in October was 90 carloads.

FORT SMITH. Another zinc smelter, of 2400 retorts, costing \$200,000 is to be erected by the Athletic Smelting Co., headed by C. T. Orr of Webb City, Missouri. The United Iron Works Co. of Springfield, Missouri, is to construct the plant.

CALIFORNIA

BARNWELL. W. B. Sharps of Philadelphia and W. W. Wishon of Searchlight, Nevada, have bonded the Copper King group of mine claims near here, of G. H. Hamstadt, for Eastern interest, and have four men assisting them in making the examination.

(Special Correspondence.) The large gold dredge on Coffee creek is nearing completion. It is reported that another boat

will be constructed next year by the same company on Graves ranch, two miles south of Carrville.—It is reported that the company which bought out the Alta Bert Gold Dredging Co. at Trinity Center, four miles south of Carrville, will construct a large boat next year.—The Nash deep-gravel mine at the head of Coffee creek, for many years owned by an English company, was recently sold for \$10,000 to a San Francisco man.—Atkins, Kroll & Co. of San Francisco have lately taken a bond on a hydraulic mine owned by Williams & Carter, situated on the north fork of Coffee creek. It is reported that the same firm, present owners of the Headlight mine, will try a new process in the spring. The mine has been shut-down for four years.—The Strode mine has been under bond for some time for \$15,000. Considerable ore was milled this season. A contract has been let for a 750-ft. adit. The same concern that has the Strode mine under bond has a bond on the Schlomberg hydraulic mine on the north fork of Coffee creek.—The Bonanza King mine has been doing a great deal of development during the past two years.—The Jubilee mine on Coffee creek, owned by McCormack, Saezter Co. of Redding, and under bond to the California Extraction Co. of San Francisco, is doing a large amount of development. The vein was recently cut in a lower adit. The Porth mine, an adjoining property owned by the same company, will do some development this winter.—There is considerable work under way up in Scott mountain, north of here, just over the Siskiyou line.

Coffee, Trinity county, November 4.

(Special Correspondence).—The latest discovery of importance at Goldstone, the new district 30 miles north of Barstow, in San Bernardino county, is in the Gold Ring mine, where high-grade ore is reported found in a four-foot vein. The 22-in. pay-streak is in the centre of the vein, with a rich strip four to six inches wide in the middle of it. The vein-material is quartz and calcite with iron oxide. The gold-bearing formations as far as explored are old sediments, probably Paleozoic, much metamorphosed. The principal rocks are limestone and quartz-schist, intruded by dikes of various character. These sediments have been tilted by uplift and dip from 20 to 70°, with pronounced fracturing and shearing. By faulting, the underlying granitic rocks have been brought to the surface along the edge of the district and these now form some of the higher hills of the vicinity. The sediments dip toward the granite and abut against it, thus indicating at least one fault of large displacement. Tertiary volcanics are found capping many of the outlying hills of the district. All of the gold-bearing veins thus far found in the camp occur in the metamorphic area, and usually at the contact of limestone with some other rock.

Goldstone, November 9.

GRASS VALLEY. Three miles of the bed of Greenhorn creek has been leased by W. H. Frickleton to L. Girdetz, who will install plant to recover the gold.

HAMMONTON. On November 20 the Yuba Consolidated will launch No. 15 dredge, one of the largest in the world.

HAPPY CAMP. The Williams Brothers' copper claims on Buzzard creek, Siskiyou county, have been bonded for \$50,000 to M. Woods of the Bank of Italy.

KENNETT. Large quantities of material are arriving for the Mammoth Copper Co.'s electrolytic-zinc plant. Construction is making good progress.

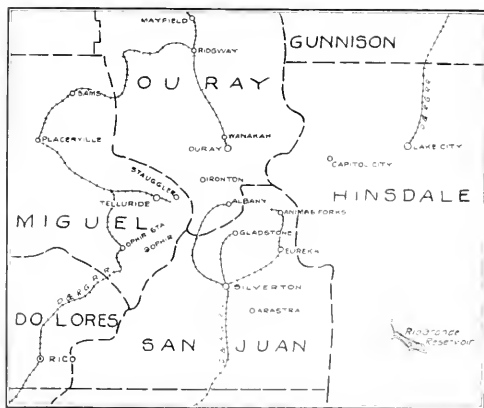
PORTOLA. It is probable that a railway will be constructed from this place into the Walker district. Either the Western Pacific or Feather River Lumber companies may extend their lines. The Walker copper mine is employing 150 men, while the mill treats 100 tons daily.

SONORA. According to the *Union Democrat*, the revival of interest in mining in Tuolumne county has been largely confined to new operations on the Mother Lode for the past two years, practically to the neglect of that highly-mineralized sec-

tion known as the 'east belt,' whose veins in the past have a producing record equal to some of the large mines on the Mother Lode. Miners and investors are now turning to this inviting field, and already in many instances limited exploration work has demonstrated that while the early miners recovered much gold from the quartz claims, many of them were abandoned before really opened, and none of them were ever worked out. In a number of these claims work has been commenced and is being pushed in a manner that makes for success. In the Columbus mine, operations are confined to driving the shaft down to the 500-ft. point. A grade of ore uncovered in development gives a value of \$10 per ton. The Carlotta, in the same vicinity, is showing some good ore. Adjoining are the North Star and Laura claims, and operations are under way in the former. The Sonora and Duffield, south of the Dreisam, is being re-opened for examination. This mine has a small vein, but it is rich in free gold and yields about 2% of high-grade sulphides. The Confidence mine is to be re-opened by a strong company, and other properties in that vicinity are being negotiated for under bond to purchase. When the legal entanglements have been straightened out in the United Mines Co. group of five claims plans for operations on a gigantic scale will be put in execution. The Chapparel mine and the Garfield group are held under option, and other properties here and there along the east belt and side-lines are receiving considerable attention, and before many months the 'music' of stamps will be continuous all about the hills within a radius of half a dozen miles of Tuolumne.

COLORADO

TELLURIDE. In the last *Quarterly* of the Colorado School of Mines, W. H. Wright details experiments on Colorado ores by flotation. A complex sulphide ore from the Smuggler-Union



PART OF COLORADO.

mine was chosen for large tests. It contained 0.36 oz. gold, 4.04 oz. silver, 1.87% lead, 5.99% iron, 1.59% zinc, a trace of copper, and 78.6% of insoluble matter. The last was principally quartz. The results are not yet complete, but so far are interesting. An extraction on one lot was 82.1% gold, 84.4% silver, 86.7% lead, 62.8% iron, and 74.2% zinc.

In an article published in the Colorado School of Mines *Quarterly*, R. W. Shumway, chief engineer of the Rocky Mountain Fuel Co., discusses the coal industry of the State. He considers that it is one of the largest factors in the business of the State, as its scope is broad and its field of operations covers nearly half of the counties of the State. One town, among others, Trinidad, with 12,000 people, depends entirely on coal. The output in 1915 was 8,715,397 tons. Colorado

produces practically all the grades of commercial coal used in the West. There are large areas of undeveloped coal, due to lack of markets.

LEADVILLE. Two carloads of high-grade iron-manganese ore has been shipped from the Penrose shaft of the Down Town Mines to the A. S. & R. smelter at Denver. This is the first ore production since the property was drained. A steady output is contemplated. The pumps are lifting 2500 gal. per minute.

SILVERTON. The Buffalo Boy, Ben Franklin, and other properties in this district have been examined by the Goldfield Consolidated Exploration Company.

IDAHO

Idaho's 33 counties cover an area of 82,888 square miles, divided principally between the Rocky Mountain region and the Columbia plateau, only a small part, in the south-east corner of the State, lying in the Great Basin. In elevation above sea-level the State ranges from 735 ft. at Lewiston, to 12,078 ft. at the summit of Hyndman peak. It is drained mainly to the Columbia through Snake river and its tributaries and has an annual rainfall of about 17 in., the range in a single year at different places being from 6 to 38 in. The industries of the State are chiefly agriculture, stock-raising, and mining. Hay, wheat, oats, and potatoes are the principal crops. A large area is cultivated by irrigation. The mineral production includes gold, silver, copper, lead, and zinc. The output of lead in 1913 was valued at \$13,986,366, that of silver at \$6,033,473. The population of Idaho in 1910 was 325,921. These are notes from the Overland Guide-book, Bulletin 612, U. S. Geological Survey.

CAMAS. Reports from the Salmon River district point to a busy season next year. The old Warrens camp has been more active.

MULLAN. Plans for the resumption of active operations at the Missoula copper mine were considered at the annual shareholders' meeting at Mullan on November 6. The property is extensively developed, and engineers' reports state that there are thousands of tons of ore available for extraction that will assay 1 to 2½% copper, and at prevailing prices of the metal it is believed that ore averaging even as low as 1% can be mined and shipped profitably.

NIMMIE. According to D. F. Bailey, consulting engineer for the Interstate Callahan company, the mine never was in better physical condition, and the outlook for further profitable development is decidedly promising. Drifts have been extended 300 ft. on both levels above No. 1, the main haulage-level and are still in ore. The addition of 300 ft. exposes the body for 1000 ft. In all, whereas the engineers had calculated on only 700 ft. Conditions suggest that the shoot may prove to be as long as on the lower levels, where it has been followed for 1300 ft. It is 7 to 15 ft. wide, and 18 ft. wide in places on the upper levels. One cut recently on the 700-ft. level, where the depth is 1600 ft., has been driven on for 100 ft. It is 7 to 20 ft. wide, and its average quality is as good as the rest of the mine. The mill feed has been 2½% zinc and 6% lead for the last 18 months. On the 500-ft. level, which is 125 ft. above No. 7, there have been installed 13 chutes, and one is in the face of the drifts. This provides a continuous rope 1300 ft. long in the richest ore exposed at any time. Plans and the organization have been completed for the flotation plant the construction of which will occupy two or three months. Impounded tailing will be removed from the dump to the plant by a continuous automatic drag. The expense of handling by this method is \$ to 10c. per ton in other places. The tailing will be ground in a tubemill, and passed on to the flotation section. There is 250,000 tons that range in content from 1 to 7%, and 1% can be treated at a profit. When the flotation plant is in operation a recovery of from 93 to 95% of the ore is expected, and an increase in the saving of lead. Operations

have been started on the Nipsic mine, where are expected some developments of importance.

WARDNER. The Stewart Mining Co. is negotiating for properties adjoining the Stewart mine, and also is seeking the right, under lease, to develop and extract ore beneath the streets and alleys of Wardner and under private property in the town. The lease is to run for 25 years, under payment of 5% of the gross proceeds from the sale of ore removed. The mayor, B. Flaig, and the board of aldermen have signed the lease for the city, and practically all the owners of private property have signed. The leases are made in the name of William A. Beaudry, managing director of the Stewart company, and his activities in this regard have caused considerable speculation.

MISSOURI

JOLIET. The ore market was strongest last week, blende increasing \$4.50 per ton to \$80. The output of the Missouri-Kansas-Oklahoma region was 6175 tons of blende, 250 tons of calamine, and 676 tons of lead, averaging \$77, \$43, and \$87 per ton, respectively. The total value was \$515,321.

MONTANA

BUTTE. For the sum of \$673,717, the minimum stipulated by the Court, the Anaconda company last week purchased the Lexington and other claims in the Walkerville district. The properties once belonged to La France Copper Co., a Heinze concern, and later to the Atlantic Mines Company.

The Anaconda company's October pay-roll amounted to \$1,672,264, a record. The wage is \$4.50 per shift.

During October the Butte & Superior produced 15,600,000 lb. of zinc from 54,450 tons of ore.

NEVADA

EUREKA. The recent rich discoveries in this old centre keep up their value in gold, silver, and lead.

TONOPAH. During the week ended November 4, eight mines produced 10,176 tons of ore valued at \$199,108. In the next week the output was 9757 tons worth \$191,566.—The Tonopah Mining Co. is averaging about 290 ft. of new openings each week, distributed in its three mines.—The Victor shaft of the Extension is 1685 ft. deep.—Two diamond and one churn-drill are prospecting new property of the Belmont.—A raise above the 1025-ft. level of the Monarch Pittsburg has opened 1 ft. of \$30 ore. The shoot has been opened for 23 feet.

NEW MEXICO

(Special Correspondence.)—At the Pacific mine the haulage-cable for the aerial tram to the Socorro company's mill was placed during the week, and the traction cable is now being installed. A good vein has been encountered in north drifts from the 500 and 600-ft. levels. The territory south of the shaft will be opened later, as present underground activities are up to the limit of hoisting equipment.

The new shaft at the Johnson mine, operated by the Socorro M. & M. Co., is down 255 ft., still in a milling grade of ore.

Ore is coming in on the south drift from the adit-level of the Clifton mine, on which the Oaks Company is conducting development work.

The slime-carrying flume being built by the Mogollon Mines Co. has been completed from the Last Chance mine to the Maud S property, a distance of about one mile, and is now in commission. This will eventually be extended about 4 miles farther down the canyon on to the present tailing impounding dams.

There are practically no idle men here, and from different quarters comes the report of a scarcity of labor of all classes to a greater extent than has been noticed for some time past.

Mogollon, October 31.

OKLAHOMA

CARDIN. W. H. Langford and associates of Kansas City and W. J. Scafe of Joplin are drilling and developing five tracts near this place, aggregating a total of 320 acres. One lot that involves a good portion of the townsite of Cardin promises to develop into one of the best properties in this part of the Oklahoma field. Twenty-four drill holes already were down, all showing some ore, but in twelve of them an unusually rich run at from the 200-ft. level down to 242 ft., and also from 220 to 245 ft. In some places the ore runs deeper than in other parts of the lease. Five or six drills are at work putting down holes as fast as possible.

UTAH

AMERICAN FORK. During the winter 18 mines will be operated. By the middle of November the Utah Power & Light Co. will have its transmission-line completed into the district.

GARFIELD. Preliminary work for the construction of a plant to treat the tailing from its mills has been started by the Utah Copper Co. The dams contain 50,000,000 tons of residue containing about 10 lb. of copper per ton.

GOLD HILL. To get its rich tungsten ore to market the Seminole Copper Co., operating in the Clifton district of the Deep Creek region, western Tooele county, has for some time been shipping by parcel post at a cost of \$26.50 per ton. The dumps contain 10,000 tons of concentrating ore.

PARK CITY. The new aerial tram at the Silver King Consolidated, 10,200 ft. long, is working well, delivering ore to the sampler and mill.

The Broadwater Mills Co., which is treating tailing near Park City, is to re-model its plant.

Good progress is reported on construction of the Judge M. & S. Co.'s electric zinc smelter.

TINTIC. In the report of Walter Fitch, general manager of the Chief Consolidated Mining Co., it is stated that during the period January 1 to September 30, development covered 17,950 ft. Ore shipments totaled 62,006 tons, assaying 0.104 oz. per ton gold, 21.37 oz. silver, 13.08% lead (on lead ore), 1.95% copper (on copper ore), and 30.5% zinc (on zinc ore), an average value of \$31.38 per ton. The net profit was \$474,247. Development was extremely satisfactory. Dividends totaled \$132,331. On October 1 the cash balance was \$446,970.

WASHINGTON

REPUBLIC. The Lone Pine-Surprise Mining Co. is preparing to begin sinking a 500-ft. shaft on its Last Chance claim at Republic. A 5-drill compressor, hoist, and a 100-hp. boiler have been ordered.

SPOKANE. The Coeur d'Alene Mine Owners' Association, of which Stanley A. Easton, general manager of the Bunker Hill & Sullivan Mining Co., is secretary, will install a comprehensive display of the minerals of the northern Idaho region in the new quarter at the Spokane hotel of the Northwestern Mining Men's Association, a re-organization of the Spokane Mining Men's club, the pioneer society in the Northwest of men interested in the mining industry.

CANADA

BRITISH COLUMBIA

SILVERTON. During September the Standard Silver-Lead company made a profit of \$38,287. The monthly dividend of \$50,000 was paid. On October 1 the balance was \$254,319. Revenue from lead and zinc products, etc., totaled \$60,176. Ore production, including mining, shipping, marketing, taxes, etc., amounted to \$36,288. In July the profit was \$56,608, \$30,398 in June, and \$136,943 in March.

TRAIL. For the 10 months of 1916 the smelter at Trail has received 415,143 tons of ore, against 399,070 tons in this period of 1915. New producers in the Slocan district are the Revenue and Sovereign; and the Johnson at Merrett.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

H. H. CLAUDET is in Ontario.

JOHN BAILLOT is at Washington.

G. W. EVANS has returned to Seattle from Alaska.

F. LYNWOOD GARRISON has returned to Philadelphia from Brazil.

THEODORE J. HOOVER has arrived at Palo Alto from New York.

A. W. ALLEN, recently with the San Juan Mines, in Argentina, is here.

H. J. SHAFER has returned to San Francisco from Dulzura, on the Mexican border.

VICTOR C. ALDERSON was in San Francisco last week, on his return from New York.

GEORGE CRICAR passed through San Francisco on his way from Spokane to Los Angeles.

EDGAR A. COLLINS is in San Francisco, the Oceanic quick-silver mine having been shut-down.

E. GYBSON SPILSBURY has gone to Cuba, and will be away from New York for about three weeks.

WILLIAM C. MADGE is in San Francisco on his return from Siberia. He will proceed to London shortly.

M. M. VALERIUS and V. H. McNUTT of Tulsa, Oklahoma, have returned from a six weeks' business trip to New York.

E. V. DAVELER, superintendent of the metallurgical department of the Alaska Gold Mines Co., is at the Palace hotel.

H. G. THIELE has resigned as assistant editor of the PRESS and has gone to Glacier, Washington, to superintend erection of a cyanide-flotation plant.

DORSEY A. LYON has returned to Salt Lake City from Washington and New York, where he has been studying operations at electro-metallurgical plants.

PAUL KRUGER, master mechanic at the Inspiration mine, leaves at the end of the month to take a position at the property of the Chile Copper Co., at Chuquicamata, Chile.

NORMAN L. WYBROD, until November 1 in charge of the powdered-coal department of the Anaconda Copper company, has become identified with the Powdered Coal Engineering & Equipment Co. of Chicago.

C. E. MILLS, general manager of the Inspiration Consolidated Copper Co., has been chosen president of the Cananea Consolidated Copper Co., succeeding L. D. RICKETTS, who retires from the office to devote his attention in a general and advisory capacity to the affairs of both these companies in New York, where he has maintained an office for the past two years.

EDGAR TAYLOR has been elected president of the Institution of Mining & Metallurgy, London, in place of Sir RICHARD REDDAINE, who felt compelled to resign owing to his position in the service of the British Government at a time when the Institution was engaged in questions affecting the taxation of mines. Mr. Taylor was President for two terms between 1906 and 1910.

The sixth annual meeting of the members of the Columbia section, A. I. M. E., will be held at the Spokane hotel, Spokane, Wash., Nov. 25. There will be a discussion on United States mining laws, flotation, land classification, State and national co-operation, etc. It is hoped every member of the section will be present and prepared to discuss any of the above subjects, or any other. Bring in an application. Advise the secretary of your present address. The nominating committee desires each member to select officers of his own choice if those named are not acceptable for any reason.

THE METAL MARKET

METAL PRICES

San Francisco, November 14

Antimony, cents per pound	12.50
Electrolytic copper, cents per pound	32.50
Pig lead, cents per pound	12.25-8.50
Platinum, soft and hard metal, per ounce	105-111
Quicksilver, per flask of 75 lb.	\$80
Spelter, cents per pound	13
Tin, cents per pound	43
Zinc dust, cents per pound	20

ORE PRICES

San Francisco, November 14

Antimony, 50% metal, per unit	\$1.25
Chromite, 40% and over, each car California, per ton	15.00
Magnetite, crude, per ton	8.00
Manganese, 50% under 35% metal not desolved	16.00
Tungsten, 60% WO ₃ per unit	17.00

At Boulder, Colorado, last week, 14 tons of tungsten concentrate was sold for over \$15 per unit. The Primos company has advanced prices to its lessees.

New York, November 8

Antimony. Considerable inquiry is reported, and \$1.50 per unit has been paid for small quantities of high-grade material.

Molybdenite. This mineral continues difficult to obtain. Quotations are unchanged at \$1.70 to \$1.80 per lb. of MoS₂.

Tungsten. For small lots of ore \$17 per unit has been paid for prompt delivery. There is active inquiry for ore contracts.

EASTERN METAL MARKET

(By wire from New York)

November 14. Prompt copper is scarce; there is an active export and domestic demand; quotations are nominal for first quarter, lead is dull, spelter is fairly active, advance in ore strengthens.

SILVER

Below are given the average New York quotations, in cents per ounce of fine silver:

Date	1914	1915	1916	Average week ending
Nov. 8	11.67	11.67	11.67	69.12
" 9	11.84	11.84	11.84	67.82
" 10	11.84	11.84	11.84	67.82
" 11	11.84	11.84	11.84	67.70
" 12 Sunday	11.84	11.84	11.84	67.70
" 13	11.84	11.84	11.84	67.52
" 14	11.84	11.84	11.84	71.68

MONTHLY AVERAGES

Date	1914	1915	1916	1914	1915	1916
Jan.	37.78	48.85	6.06	34.90	47.52	63.06
Feb.	37.53	48.45	6.04	34.35	47.11	66.07
Mar.	38.01	50.61	6.09	35.11	48.77	68.54
Apr.	38.52	50.22	6.12	35.11	49.10	67.86
May	38.21	49.81	6.12	35.11	48.88	67.86
June	38.41	49.02	6.11	35.11	48.88	67.86

The past week has witnessed a sharp drop in silver, with the new high price remaining fairly steady. London reports that America has been selling freely, but has been showing little interest, and China a large quantity of goods. Stocks at Shanghai remain fairly constant at 1,000,000 and 1,500,000 in Mexico in dollars.

The merchant silver market is active, and silver valued at \$10.00 per ounce for export and for use.

Silver bullion, imported from Europe, is now valued at \$12.236.

COPPER

Prices of electrolytic copper, in cents per pound:

Date	1914	1915	1916	Average week ending
Nov. 8	11.67	11.67	11.67	68.56
" 9	11.67	11.67	11.67	8.50
" 10	11.67	11.67	11.67	8.50
" 11	11.67	11.67	11.67	8.47
" 12 Sunday	11.67	11.67	11.67	8.50
" 13	11.67	11.67	11.67	8.75
" 14	11.67	11.67	11.67	11.46

MONTHLY AVERAGES

Date	1914	1915	1916	1914	1915	1916
Jan.	11.41	13.49	13.99	11.41	13.99	13.66
Feb.	11.41	13.49	13.99	11.41	13.99	13.66
Mar.	11.41	13.49	13.99	11.41	13.99	13.66
Apr.	11.41	13.49	13.99	11.41	13.99	13.66
May	11.41	13.49	13.99	11.41	13.99	13.66
June	11.41	13.49	13.99	11.41	13.99	13.66

Export of copper during last week, 11,250 lb. compared with 11,750 lb. the previous week.

amounted to 135,541,187 lb. compared with 34,442,615 lb. Imports of copper were 326,448,620 lb. against 196,281,944 pounds.

Twenty-five mines in North and South America produced a total of 1,841,159,718 lb. of copper in the first 9 months of this year.

Anacosta produced 31,500,000 lb. in October; Shannon, 757,000; East Butte, 1,650,000; Inspiration, 11,300,000; Chile Copper, 1,542,000; Kennecott, 7,200,000; Shattuck, 1,663,671; and Arizona Copper, 1,900,000 pounds.

Champion, Michigan, has declared \$6.40 per share, making \$19.80 for the year. Anacosta is now producing copper at the rate of 1,000,000 lb. daily.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	1914	1915	1916	Average week ending
Nov. 8	11.67	11.67	11.67	7.08
" 9	11.67	11.67	11.67	7.05
" 10	11.67	11.67	11.67	7.00
" 11	11.67	11.67	11.67	7.00
" 12 Sunday	11.67	11.67	11.67	7.00
" 13	11.67	11.67	11.67	7.00
" 14	11.67	11.67	11.67	7.00

MONTHLY AVERAGES

Date	1914	1915	1916	1914	1915	1916
Jan.	11.67	11.67	11.67	3.80	5.59	6.10
Feb.	11.67	11.67	11.67	3.80	5.59	6.10
Mar.	11.67	11.67	11.67	3.80	5.59	6.10
Apr.	11.67	11.67	11.67	3.80	5.59	6.10
May	11.67	11.67	11.67	3.80	5.59	6.10
June	11.67	11.67	11.67	3.80	5.59	6.10

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	1914	1915	1916	Average week ending
Nov. 8	11.67	11.67	11.67	9.31
" 9	11.67	11.67	11.67	9.98
" 10	11.67	11.67	11.67	9.81
" 11	11.67	11.67	11.67	9.75
" 12 Sunday	11.67	11.67	11.67	10.27
" 13	11.67	11.67	11.67	10.68
" 14	11.67	11.67	11.67	11.23

MONTHLY AVERAGES

Date	1914	1915	1916	1914	1915	1916
Jan.	11.67	11.67	11.67	1.75	20.54	9.90
Feb.	11.67	11.67	11.67	1.75	14.17	9.93
Mar.	11.67	11.67	11.67	1.75	14.11	9.18
Apr.	11.67	11.67	11.67	1.75	14.11	9.92
May	11.67	11.67	11.67	1.75	14.11	9.92
June	11.67	11.67	11.67	1.75	14.11	9.92

American Zinc, Lead & Smelting Co.'s profits for the third quarter of 1916 were \$1,713,000, plus \$725,000 from its Granby properties.

During the third quarter of 1916 the New Jersey Zinc Co.'s net profit was \$8,189,511, of which \$6,650,000 was paid in dividends.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds.

WEEK ENDING

Date	1914	1915	1916	1914	1915	1916
Nov. 8	11.67	11.67	11.67	80.00	80.00	80.00
" 9	11.67	11.67	11.67	80.00	80.00	80.00
" 10	11.67	11.67	11.67	80.00	80.00	80.00

MONTHLY AVERAGES

Date	1914	1915	1916	1914	1915	1916
Jan.	11.67	11.67	11.67	37.50	95.00	81.20
Feb.	11.67	11.67	11.67	37.50	95.00	81.20
Mar.	11.67	11.67	11.67	37.50	95.00	81.20
Apr.	11.67	11.67	11.67	37.50	95.00	81.20
May	11.67	11.67	11.67	37.50	95.00	81.20
June	11.67	11.67	11.67	37.50	95.00	81.20

TIN

Prices in New York in cents per pound.

Date	1914	1915	1916	1914	1915	1916
Jan.	11.67	11.67	11.67	31.60	37.38	38.37
Feb.	11.67	11.67	11.67	31.60	37.38	38.37
Mar.	11.67	11.67	11.67	31.60	37.38	38.37
Apr.	11.67	11.67	11.67	31.60	37.38	38.37
May	11.67	11.67	11.67	31.60	37.38	38.37
June	11.67	11.67	11.67	31.60	37.38	38.37

TIN IN AMERICA

As of Nov. 15, 1916, the tin smelter at Perth Amboy, designed to produce 2,000 tons of metal monthly, is only yielding 300 tons. The output is to be doubled.

Eastern Metal Market

New York, November 8.

Copper producers are sold-up well into next year. Millions of pounds have been purchased at advancing prices in the past 10 days, and deliveries in the remainder of this year can only be had at premium prices. Only one thing could impair the future of the metal—a failure to consume the copper already purchased, and this is unlikely, considering that the brass and copper mills continue to be offered business that they cannot handle.

Though it has quieted down considerably, zinc had an active period, both galvanizers and brass mills buying freely. Dealers have sought to acquire stocks on a rising market.

Lead has been quiet in every direction, but prices have been well maintained.

In tin the week has been quiet, but prices are a little stronger.

Antimony, except for one good transaction, has continued dull. Asiatic grades are quoted at 12.75 to 13.25c, duty paid.

Aluminum prices are a trifle easier at 63 to 65 cents.

The pig-iron trade faces a run-away market. It is excited, and even at higher quotations the producers are reluctant to sell, feeling that still higher prices will yet prevail. Coke is equally excited, prompt foundry coke being up to \$9.50 per net ton at oven. Prompt furnace is quoted up to \$7.75 per ton. Eastern Pennsylvania No. 2X foundry iron is quoted at \$25 to \$27.50, delivered. Basic has sold at \$25 to \$25.50, delivered. Standard low-phosphorus iron is quoted in the East at \$43 to \$45 per ton, delivered. Western prices are commensurate. The production of pig iron in October broke all records, the month's production being 3,508,849 tons, or 113,189 tons per day, against 3,202,366 tons in the 30 days of September, or 106,745 tons per day. The October output represents a yearly output of 41,700,000 tons. The pressure on the steel mills, for plates, shapes and bars, is so great that some of them are refusing to quote for next year, except to cover contracts which the prospective buyers actually have in hand. Railroad-car builders are eager to cover their requirements at present prices, having abandoned hope of lower quotations. In the past three weeks the railroads have placed orders for at least 30,000 cars. The leading producer of steel and its products quotes 3.25c, Pittsburg, on tank plates, 2.80c, Pittsburg, on structural shapes, and 2.70c, Pittsburg, on bars; but these are nominal prices, inasmuch as deliveries made on them are indefinite. Specified deliveries are commanding 4c, or more for plates, 2.85 to 3c, for shapes and 2.85c, (all Pittsburg) for bars. An Eastern mill has advanced its plate price to 4.75c, Pittsburg base.

COPPER

The aggregate of sales in the past few days is large, some estimates placing the amount of electrolytic taken by consumers in the first six days of the month at 75,000,000 lb. Metal for delivery over the remainder of this year, and even in the first quarter of next, is scarce, and it is more than likely that extremely high premiums will be asked for prompt from this time on. Most of the buying called for first-quarter deliveries, although considerable November and December was wanted also. Large as recent sales have been, they undoubtedly would have been larger had the copper been available for the desired deliveries. The brass mills have been large purchasers. In a few cases sales have been made over the first half, and in one instance a sale is reported for delivery throughout the coming year. Quotations for nearby deliveries are covering a wider spread than usual, and with actual prices mostly a matter for private negotiation, it is difficult to closely gauge the market. Prompt and November is conservatively held at 29 to 29.50c, although a sale of spot

metal is reported at 31c. For shipment throughout 1917 a large block was sold at 26.75c. December is quoted at about 29c., January at 28.50c., February at 28.25c., and March at 28c. Getting copper nearer than March is a difficult matter. Lake is more easy to obtain than electrolytic, especially arsenical brands. A large quantity of the latter was sold last week for March delivery at 28c. Prime Lake is priced about the same, or a little lower, than electrolytic. On Monday, November 6, the day preceding the election, the market was active here, and excited in London, the latter advancing £1 10s. to £144. Foreign stocks showed but little change according to the last fortnightly statement. Total stocks in Great Britain and France, October 31, amounted to 5458 tons, against 5796 tons, September 30. Total stocks in those countries, combined with those afloat from Chile and Australia, amounted to 19,168 tons, October 31, against 19,371 tons a month previous. Imports of copper were large in the first nine months of this year, amounting to 156,000 tons, against 137,500 tons in the entire year 1915. These imports include, ores, matte and regulus reduced to fine copper. Students of the War predict that it will last at least two years longer and, needless to say, as long as it lasts, copper will be scarce and prices strong.

ZINC

In keeping with the movement in copper zinc has been active, although the demand now appears to be easing off. Producers are optimistic, and have such faith in the future of prices that they are not willing to sell freely. Dealers, on the other hand, are anxious to buy, and it should not be forgotten that they make their living to a considerable extent in accurately forecasting market conditions. Brass mills and galvanizers both were active last week. The New York quotation, November 6, yesterday, election day, being a holiday, was about 10.75c, and that at St. Louis 10.50c. December is held at 10.37½c, and upward. St. Louis, and first quarter at 10.25c. St. Louis. Exports in the first six days of the month totaled 2861 tons. The spot quotation at London on the 6th was £53 5s., against £52 15s. a week previous. Sheet zinc is quoted at 16c., f.o.b. mill, carload lots, 8c. off for cash.

LEAD

The market has been quiet, but steady, and almost entirely devoid of feature in the past week. The A. S. & R. Co. continues to quote 7c., New York, and 6.92½c., St. Louis. The independents also quote 7c., New York, but are willing to make a slight concession for delivery to Eastern points. At St. Louis the smaller producers ask about 6.87½c. The exports of six days of this month total 678 tons. The London quotation for spot, on the 6th, was £30 10s., which was the quotation of a week previous.

TIN

In this metal the week has been a quiet one, but, nevertheless, an advance in price is shown. Spot Straits was quoted on November 6 at 42.75c, and spot Banca at 41.75c. On the 3rd the market was interested, but not excited, by the news that the steamer *Glenbanan*, with about 350 tons of tin aboard had been sunk in the Mediterranean by a submarine. Ordinarily such news makes the market jump, but this time consumers were mildly indifferent. Perhaps it was because they have been fooled so many times. The supply of spot Banca tin was nearly cleaned-up lately, but more Banca will be available as offerings of future shipments from Batavia are now being made. Arrivals this month total 295 tons, and there is afloat 1377 tons. In September, 88,222 lb of tin, valued at \$45,394, was imported at San Francisco and 1,445,234 lb., valued at \$552,485, was imported in the Washington district.

Company Reports

ROUND MOUNTAIN MINING CO.

In the report of the president, L. D. Gordon, and superintendent, R. H. Ernest, of this company operating a mine, mill, and gravel deposit in Nye county, Nevada, the placer operations are discussed. Results this season, up to July 1, were somewhat disappointing, both in yardage and value. Water was also lacking. Churn-drilling and blasting ahead of the glants is being done, and other improvements to methods applied. From July 13 to September 3, 1915, there was sluiced 18,150 cu. yd. of gravel, yielding \$2,006 per yard, at a cost of 60.9c. Irregular work from November 1915 to March 1, 1916, recovered \$1,746 per yard from 5272 yd., costing \$1,023 per yard. Several difficulties tended toward this latter high cost. From March 1 to July 1, 1916, 112,600 cu. yd. yielded 33.8c, at a cost of 19.5c per yard. The gross yield for these four months was \$18,177, but the bed-rock and sluices are estimated to contain between \$20,000 and \$30,000, making, say, 50c per yard for the lot.

Original estimates of the value of the placer deposit, \$1 per yard, were based on previous hydraulic mining and sampling, the former work yielding \$1.55 per yard. Topography of the ground, a ridge under the gravel, probably has caused a variation in the gold-content, and this condition was not found out in time to cut new races into richer ground. Pan tests indicate an improvement to the north, and the influence of the ridge is diminishing as the new cut is carried easterly. The remainder of the season should yield highly-profitable ground.

The main tailing-dump is to be extended to another block of ground, and line it with steel rails. Wood blocks and boulders delayed work during the season. Costs are expected to be lowered to 15c per yard.

GRANBY CONSOLIDATED MINING, SMELTING & POWER CO.

Operations of this company in British Columbia show expansion in each annual report, that for the year ended June 30, 1916, being no exception. In the reports of the managing director, F. M. Sylvester, superintendent of mines, O. B. Smith; mine superintendents, C. M. Campbell and E. E. Campbell; superintendent of smelters, W. A. Williams; and smelter superintendents A. J. Bone and W. B. Bishop, the following details are given:

At Phoenix the Knob-Hill Ironside mine produced 760,693 tons of ore averaging 0.95% copper from the Victoria shaft, and 193,206 tons from No. 2 tunnel, containing 1% metal. The cost on cars was 82c and \$1.10 per ton, respectively. Reserves total 3,530,296 tons of regular grade, compared with 1,171,005 tons at the beginning of the year. The Gold Drop mine yielded 112,100 tons of 0.95% ore, at a cost of \$1.32 per ton. This mine was considered depleted, but diamond-drilling has found 100,000 tons additional ore, which can be mined for \$1.40 per ton. Development at this group of mines totaled 11,608 ft., costing 15 1/2c per ton; also 11,392 ft. of drilling. The average cost was 9 1/2c per ton crushed on cars.

At Hidden Creek underground work totaled 2333 ft., also 5873 ft. of drilling. Reserves in the four orebodies total 18,018,020 tons, over half of which is high-grade material. The mine produced 725,821 tons, at a cost of 39.6c per ton on cars, including all charges. The haulage-system is being improved. The crusher averaged 296.2 tons per hour during the year, that is, 1537 hours of operation, or say 90 hours daily. The new crushing-plant was completed in January. Cold weather affected the power supply. Diamond drilling using hollow steel superspeed large piston drills, to advantage. There was some unrest among employees, but this was settled.

The output from all mines was 1,889,253 tons, averaging

28.13 lb. copper, and 63c. in gold and silver per ton. The mines contain over 23,000,000 tons of ore developed, and are equipped and ready to produce 4000 to 5000 tons daily. Of 2 to 2 1/2% ore there is 9,947,000 tons, of 1 to 1 1/2%, 3,718,000 tons, and less than 1%, 9,491,000 tons.

At Grand Forks, 7.27 furnaces reduced 1,166,015 tons of ore, matte, converter slag, and flue-dust, at a cost of \$1.237 per ton, an increase of 5c. per ton. Coke consumed was 13.42% of the charge of ore. Including 4,801,355 lb. of copper in Anxoy matte, the output was 15,989,730 lb. Converting cost 6c. per ton. Slag contained 4.2 lb. per ton.

An average of 3.2 furnaces at Anxoy reduced \$22,919 tons of ore, and a total of 1,103,825 tons of all materials. Smelting and converting cost \$1.804 per ton of ore. Hidden Creek ore was more silicious and aluminous than before. Double smelting was tried with success. There were 278 men employed.

Summarizing, the year's results were as follows:

Ore treated from company's mines, tons.....	1,897,251
Recovery, pounds of copper	22.36
Total copper, pounds	42,198,083
Silver, ounces	487,845
Gold, ounces	44,848
Revenue from metals sold (copper averaging 22.04c.)	\$10,482,709
Cost, cents per pound	12.98
Profit	\$3,819,295
Dividends	\$99,911
Surplus	\$2,919,384

Cash and metals on hand amount to \$2,927,317, and accounts payable \$281,597. The company treated 31,954 tons of custom ore, yielding 3,356,570 lb. copper, 41,346 oz. silver, and 2100 oz. of gold.

LAKE VIEW AND OROYA EXPLORATION

This is a holding company, having interests in mines throughout the world. In the report dated October 13, 1916, it is stated that the profit was \$12,971, plus the previous balance and reserve account income, making \$42,766. Dividends amount to \$36,095. The balance is \$164. The technical committee, consisting of J. A. Agnew, J. H. Cordner-James, Theodore J. Hoover, and A. F. Kuehn, made the following remarks on some of the properties.

BURMA CORPORATION. The last official estimate of ore reserves at the beginning of July, 1916, gave 3,240,000 tons of ore already proved and probable above the Tiger tunnel, with anticipated extensions down to this opening of 650,000 tons. Owing to a concentration of effort on the completion of the adit, development has not proceeded as rapidly since the end of the last half-year as previously; nevertheless, such work as has been carried out justifies a further addition of 160,000 tons to the reserves, making a total of 3,400,000 tons. In addition to this tonnage, it may be safely estimated that there will be additions down to the Tiger tunnel of a further 600,000 tons. The total proved and probable ore and anticipated additions to the orebody above the tunnel is therefore, in round figures, 4,000,000 tons, averaging 25 oz. silver, 27 1/2% lead and 22 1/2% zinc. The Chinaman orebody has been developed for a length of 1200 ft., with a width varying up to 140 ft. The Tiger tunnel holed through to the internal shaft workings on September 24, thus confirming accurately the estimate made by the Technical Committee of the Burma Corporation. This tunnel has taken 29 months to drive 7300 ft., or a little over 250 ft. per month, which, considering the times, was excellent progress. The burden of pumping and hoisting will now be completely dispensed with, and development can proceed rapidly on the lower levels of the mine. That this is true is confirmed in the last published telegraphic report of the manager, which indicates that he is now in good grade ore on the Tiger tunnel level, assaying 29 oz. silver, 30% lead and 18% zinc. An interesting event will

now be in prospect, that is, extending of the Tiger tunnel through the orebody, thus opening the Chinaman orebody at a depth of some 700 ft. below the surface. This tunnel will also ultimately cut the vertical shaft workings and make available not only the high-grade lead-silver ore in that section, but also 30,000 tons of high-grade copper ore, assaying upwards of 15% copper. It is hoped to reach this position during the present high prices of copper. There are three furnaces in operation at the mine, and one of these can be readily converted to reduce copper ore.

Smelting operations have been carried on continuously, and the plant is now working at the rate of 3000 tons per month of ore from the mine and 500 tons of slag. From these the yield is a little over 1200 tons per month of lead and 70,000 oz. of silver, both of which products are realizing good prices.

Design of the new lead-concentrating mill is now practically completed, and detailed plans and specifications are being prepared for the first unit of 333 tons per day. Orders will shortly be placed for the machinery, and as manufacturers are able to promise fairly prompt delivery it is not anticipated that there will be much delay in installation. This unit will be followed shortly by two others of the same capacity, bringing the total up to 1000 tons per day. The Technical Committee has estimated the profit per ton at \$12 at pre-war prices of metals.

ZINC CORPORATION. Development continued throughout the year, the main shaft having reached a depth of 1522 ft. Exploration on No. 8 and 9 levels continues to show large bodies of good milling ore. On No. 10 the orebody has been proved as satisfactory by diamond-drilling and cross-cutting. Reserves show a considerable increase compared with the previous year.

Operations in the zinc treatment department were resumed at the beginning of the year. Unfortunately, owing to a strike, the plant was closed down from January 10 to February 14, this affecting adversely results of the first two months of 1916. However, up to the end of August, 28,863 tons of zinc concentrate was produced, which has been sold at remunerative prices. The lead mill has continued in operation at practically full capacity, with the exception of the first two months of the year, when the mine was closed down, and has produced 18,018 tons of lead concentrate. This output has been sent to the Broken Hill Associated Smelters, in terms of an agreement with that company, and at the high price of lead now prevailing shows a handsome profit. This company, at the prevailing price of metals, has therefore been earning profits at the rate of about \$96,000 per month, and during July and August, when the zinc plant was running full time, the profits were about \$145,000 per month.

LAKE VIEW AND STAR. During the six months to August 31 last this company treated 96,898 tons, which yielded bullion worth \$98,285, while the working expenses, including development, for the same period amounted to \$100,749. During the year ended February 28 last, dividends aggregating 15% on the company's capital were paid; no dividend has been distributed for the current year.

The estimate of ore in reserve on February 28 last was 353,527 tons worth \$6.20, compared with 426,301 tons worth \$6.40 at the close of the previous year. The figures do not include any ore in the Chaffers mine, in which, according to reports made before the mine closed down, are 74,892 tons worth \$7.30 per ton. The mine has been adversely affected by war conditions in combination with a run of low-grade ore in the stopes. The rise in the cost of supplies, shortage and inefficiency of labor, and inability to obtain bromo-cyanide, which had hitherto been considered essential for economic treatment of the ore, have in the aggregate added greatly to working costs, and increased the loss of gold in the residue. To meet the altered conditions a scheme of treatment without bromo-salts was evolved, and the plant adapted to the altered circumstances; but the new method of treat-

ment, although promising, does not so far give as good a commercial result as was obtained by the old system.

This property is at Kalgoorlie, Western Australia.

CENTRAL AMERICAN MINES. Since the date of the last report issued by this company great difficulties have arisen in connection with development in the bottom of the mine. The flooding of the No. 2 level and shaft, due to breaking into an accumulation of water in old Spanish workings in the San Basilio section, proved to be more serious than the first advices indicated; further difficulty arose later through the caving of the shaft timbers between the surface and No. 1 adit-level. The delays consequent on these happenings have, as may be realized, caused much delay in opening the third level. Further difficulties, directly attributable to the War, have arisen, and their accumulated effect is such as to make it impossible to continue working without some re-organization of the company's position. The cost of almost all stores has materially increased, wages have had to be raised to all classes of workmen, the exchange rates both in Nicaragua and America have disadvantageously operated, and shipping on the Pacific Coast is so infrequent and irregular as to derange repeatedly the company's operations. Under these circumstances the directors have under consideration the matter of suspending treatment operations, and continuing the development pending some immediate decision being arrived at regarding the re-financing of the company.

During the year ended December 31, 1915, there was 27,849 tons of ore treated for a yield of £47,194; working expenses amounted to £40,260, showing a profit on revenue account of £6934; of the latter, shaft-sinking absorbed £1020, mine development £1545, and construction and equipment £2024, leaving a net profit in the Republic of £2345.

BABILONIA GOLD MINES. The work carried out at this property has been, on the whole, of a satisfactory character. The east Crimea shoot has been opened on the second level, the west shoot on the same level has opened well, while of much importance is the finding of a practically continuous shoot of ore between these main blocks, in the hanging-wall portion of the orebody at No. 2 level, an area that hitherto had been regarded as valueless. The latter work led to further prospecting in the hanging wall of the No. 1 adit-level, and—more recently—in No. 2 adit, in each case with success. While this ore is lower in grade than the main east and west shoots on the Crimea vein, it is highly profitable.

The plant continues to give excellent results, both in the matter of capacity and extraction. For the year ended December 31, 1915, there was 9586 tons of ore and 5724 tons of accumulated slime treated for a return of £37,152. The expenditure under the heading of working costs was £24,445. The profit above working expenditure was £12,707, or a net profit of £5279, after allowing for the cost of mine development of £7428. This mine is in Nicaragua.

CONSOLIDATED INTERSTATE-CALLAHAN MINING CO.

In the third quarter of 1916, this company, operating in the Coeur d'Alene, Idaho, shipped 3297 tons of crude ore averaging 50.5% zinc, 14,184 tons of concentrate averaging 47.7% zinc, 388 tons of crude ore averaging 18.9% lead, and 1121 tons of concentrate averaging 19.4% lead. The total metal in the shipments was 16,868,836 lb. of zinc and 1,454,562 lb. of lead. The combined cost of mining and milling was \$6.302 per ton. The mill recovery was 85.7% of the metal-content, an increase of 4.71%. The net value of shipments was \$655,034, against \$997,182 for the preceding three months. The profit was \$413,695, compared with \$713,677. \$1.50 per share was distributed, totaling \$697,485.

The advance report on gold, silver, copper, and lead in South Dakota and Wyoming has been issued by the U. S. Geological Survey. The value of the precious metals was \$7,507,636 and \$15,018, respectively.

Industrial Notes

Information supplied by the manufacturers.

Improved Miner's Lamp

Two improved forms of the General Electric miner's lamp have been recently approved by the U. S. Bureau of Mines. Form C has a case of drawn and tinned sheet steel, while the form D battery container consists of 1-in. aluminum alloy casting, 99% pure aluminum. Otherwise the lamps are identical.

The cap lamp is a steel shell lined with fibre insulation, and contains the reflector of porcelain-enamelled steel and phosphor-bronze spring contacts rigidly mounted. The latter hold the Mazda lamp bulb in such manner that it is shattered and expelled from the contacts by a blow that otherwise



IMPROVED MINER'S LAMP.

would be only sufficient to crack or chip the glass bulb as usually mounted. This prevents the heated filament coming in contact with inflammable gas. Double steel hooks, electrically welded together and riveted to the shell, provide means for attaching the lamp to the miner's cap. The cap lamp is waterproof and weighs four ounces. The weight on the cap is from six to eight ounces, depending on how the lamp and cable are worn.

The lamp is a one-half candle power wire-drawn Mazda with a guaranteed life of 300 hours. It has two contact bases, and a single filament running straight through the bulb together with the reflector produce a well diffused illumination at an angle of 130°. A 13-in. cable connects the lamp to the battery. This is made for the unrestricted movement of the miner. It is double twisted strand copper, rubber coated individually and together and the whole rubber coated. The weight is 5 ounces. This construction gives a strong, light, flexible, non-linking cable, of low resistance. Protection at each end is afforded by steel spring armor, double at the battery and single at the lamp. The cable is fastened in the lamp and battery cover entrance by being held under pressure secured with lock-nut. It will stand a heavy strain without loosening or putting undue strain on the terminals of the conductor.

Both forms have approximate outside dimensions of thickness 2 in., height 6 1/2 in., and width 5 in. Total weight, form C, 4 lb. 7 oz. and form D, 4 lb. 13 oz. All metal parts are finished with a semitransparent gold proof lacquer, which gives a serviceable and pleasing appearance.

The battery is an non-leak exide, iron clad, self-contained and exide negative. It is guaranteed to give a capacity of at least 10 hours per charge for about a period of two years. The plates are contained in a medium weight rubber non-spillable case, ribbed vertically for strength and secured

with a special vent and filling plug. The cover is so constructed that the pressure of the contacts on the terminals strengthens the seal. All parts of the entire outfit are interchangeable. No gas is generated on discharge, and explosions are therefore impossible.

The outfit will operate submerged in water; it is safe, durable, efficient, and easy to wear; the light cannot be extinguished except by intentional disabling, and the outfit may be sealed so that tampering will be rendered visible.

Commercial Paragraphs

In Bulletin 64 the CHAIN BELT Co. of Milwaukee illustrates its chain-belt traveling water-screens, which are giving good results at large power-plants.

'Roebling Wire Rope' No. 4 contains notes on electric cranes, rope, tackle, slings, aerial conveyors, derrick, and increased efficiency in mine-rope service.

Denver 'Clipper' drills are the subject of Bulletin C-3 of the DENVER ROCK DRILL MANUFACTURING Co. Models 50 and 55 may be used as hand drills or mounted for any work about a mine or quarry.

Among the interesting mechanical notes in 'The Excavating Engineer' for October there is given the record of a class 45, 2 1/2-yard Atlantic (Bucyrus) steam-shovel that loaded 82,500 cu. yd. of sand and clay in 24 1/2 days of 10 hours each.

Manganese-steel sand and gravel-pumps, and wearing parts for pump-dredges are discussed in Bulletin 72 of the AMERICAN MANGANESE STEEL Co. of Chicago. The publication shows centrifugal-pump details, all parts of which are of manganese steel.

Railway motor gears and pinions are illustrated and discussed in Bulletin 14,419 of the GENERAL ELECTRIC Co. These wheels are of the forged or solid cast-steel make. Split wheels are reinforced and have lock-nuts on the bolts. Useful notes are given on correct and incorrect mesh of the teeth.

In the October issue of 'Leschen's Hercules,' St. Louis, some details are given of erecting a 60,000-kw. steam-power plant near Buffalo, how an aerial tram 584 ft. long across a river saved a two-mile haul in Wyoming; coal mining in West Virginia, and the beet-sugar industry of the United States. In all of these operations wire rope is used.

The NORDBERG Mfg. Co., of Milwaukee, Wis., announces the appointment of H. W. Dow as sales manager. He has been associated with the company in the engineering and sales departments for 12 years. The Nordberg company builds steam and electric hoists, Corliss engines, poppet-valve engines, millow engines, air-compressors, oil-engines, and Nordberg-Cards Diesel engines.

Single compressors, steam driven with balanced steam valve and automatic fly-wheel governor, are described in Bulletin 31-Z of the CHICAGO PORTLAND TOOL Co. Some details of construction are given, with a section showing the whole engine.

Bulletins 31-K and 31-X deal with fuel-oil driven compressors and engine gas engines. Considerably detailed photographs of parts are shown.

An unusually well-illustrated bulletin of the ALLIS-CHAMBERLAIN MANUFACTURING Co. of Milwaukee, Wisconsin, deals with pumping engines. The new type made is the horizontal, cross-compound, crank and fly-wheel pumping-engine, the latest step in the evolution of high-duty pumping-engines. Considerable detail, with drawings, is given on this machine; also indicator cards of tests. In Bulletin No. 1810 this firm illustrates a ball-steel jaw-crusher, made in three sizes, namely, 36 by 24 by 18, 36 and 60 by 18. A picture shows a double-drum automatic electric hoist for rock-crushing plants.

EDITORIAL

T. A. RICKARD, Editor

COPPER at 33 cents has reached the highest price since 1873. A 'famine' is claimed to exist at New York. Urgent demand is reported for April and May delivery. Most of the producers are out of the market until July of next year. Spot copper has disappeared as an item of trade.

STRONTIUM NITRATE is a chemical product that is now being made in California, as described on another page by Mr. Donald F. Irvin. The mineral celestite, the sulphate of strontium, is one of the ores found in the southern part of this State, and the manufacture of the nitrate is done locally at Los Angeles and Long Beach.

UPON another page we give some notes on the hearing of the Hyde flotation case before the Supreme Court. Nearly three days were given to the arguments and it is said that a more distinguished group of counsel has rarely thronged the Capitol. The decision may be delayed by the technical intricacy of the subject, but it is expected before the close of the year.

OUR French contemporary *L'Echo des Mines* acknowledges the efficiency exhibited by the Austrians in re-opening the Serbian mines after the tide of military invasion had passed. Copper, lead, and antimony are being produced in considerable tonnage at various points, such as Rudnik, Cavonj Breg, Dorspotok, and Majdanpek. The work is being done under military organization.

MISGIVINGS over our phenomenal prosperity are multiplying; and it is a good sign. Something is needed to curb the debauch of speculation that is now in full swing. The sagacious captain of industry will deprecate the assumption that present conditions can persist and he will prepare for the shock of peace that will come as surely as the crisis that followed the declaration of war nearly 2½ years ago.

THANKSGIVING finds the people of the United States enjoying a peaceful prosperity that is all the more remarkable by force of contrast with the conditions obtaining in Europe. The President's proclamation of November 30 "as a day of national thanksgiving and prayer" not only urges our people "to resort to their places of worship . . . to render thanks" but it also suggests that they should "think in deep sympathy of the stricken peoples . . . upon whom the curse and terror of war have so pitilessly fallen," and it recommends

them to contribute of their abundant means to the relief of suffering. That was a worthy touch and we hope it may be heeded.

PLAGIARISM of the unconscious kind is not deemed a terrible sin, but deliberate plagiarism finds little excuse. Recently we drew attention to the use of the title 'The Flotation Process' by a New York publisher after that title had been used for a book published by us. Now a mining paper at Chicago follows the example of the New York publisher and issues a third book on the same subject under the same name. The title of a book cannot be copyrighted by law, but there is a convention of good taste that usually suffices to prevent confusing, if not misleading, employment of any name already in use. Some people have a lot of taste, but it is all bad. We think it proper to draw the attention of the profession to a trespass that is both stupid and indecent, and we express surprise that the respective authors, Messrs. Herbert A. Megraw and H. J. Stander, should have lent themselves to such a performance. That redoubtable Arizonan hero, Billy the Kid, would call it "plumb mean."

IT is six years since the beginning of the Madero revolution and yet Mexico is no nearer the political reform of which he dreamed. The Joint Commission, having served to postpone fresh complications until after our presidential election, is about to be dismissed, without result. Arrangements for patrolling the border are of small consequence compared with the ending of the bloody anarchy to which the country is still subject or the taking of some measures to protect the lives and property of our citizens operating there under the implied sanction both of their own Government and that of Mexico. The Carranza government is now insisting upon a return to the 1912 scale of wages at the mines and upon payment in gold, at a time when exchange stands at 60:1. Letters from Mexico bear a stamp of one peso, instead of the 5-centavo stamp that formerly sufficed for postage. Conditions at the mines are precarious and strikes have been started in several localities, notably in Jalisco.

FLOTATION in its simplest and most effective application is illustrated in the article by Mr. Hallet R. Robbins describing the Union mill of the Calaveras Copper Company. The simplicity of the flow-sheet will appeal to mill-men; so will Mr. Robbins' admirably clear description. Chalcopyrite in schist makes an ore readily amenable to flotation, as we have seen at the Britannia. The excess of barren pyrite might have proved an ob-

stacle to concentration by froth, as it was to ordinary wet gravity methods, but fortunately the greater hardness of the pyrite (6 to 6½) as compared with the chalcopyrite (3 to 3½) causes the former to break more coarsely and so deters the flotation of it in favor of the copper-bearing sulphide. Here we have an example of selective crushing followed by preferential flotation. In some respects the Calaveras treatment resembles that at Engels, as described in our issue of July 31, 1915. At Engels, magnetite proved a deterrent to water concentration, diluting the percentage of copper in the concentrate, and there also the difference between the hardness of the chalcopyrite and its associated sulphides became an aid to flotation. This process requires fine grinding, which is in most cases a favorable economic factor because the closer comminution of sulphides is inevitably accessory to the crushing of them. On the other hand, the need for fine grinding precedent to flotation may prevent the adoption of the froth process as against cyanidation, particularly in mills treating ores valuable chiefly for their gold contents. The success of the work at the Union mill is imputed by Mr. Robbins to the adoption of the pneumatic method of making froth; he gives a detailed drawing showing in what way the porous bottom differs from the conventional type and he describes the manipulation of the 'air-pans.' It will be noted that the consumption of oil is low—less than ½ pound per ton of ore. The best tribute to the excellence of the metallurgical treatment is the poverty of the tailing, which contains as little as 0.01% copper. Truly it is a result that does credit to all concerned. The recovery is over 96%, this splendid figure comparing with the 50% recovered by ordinary water concentration. This is another remarkable tribute to the efficiency of the flotation process.

TAXATION of mines is threatening to injure business in the city of London. For many years the British metropolis was the mining centre of the world but it is becoming recognized that the heavy taxation incidental to the War may make it undesirable to register mining companies at Somerset House or to direct them from the north bank of the Thames. An equally important factor is the probable discouragement to the British public, which during the last half-century has been the most consistent and courageous supporter of mining enterprise. Unfortunately the economies of mining are not understood by the tax collector, chiefly because he has been misled by his victims into believing that a mine is an 'investment' and that dividends are 'income.' An engineer described as 'a mining authority of world wide reputation,' writing in Mr. F. W. Hirst's new paper, *Common Sense*, says: "A mine with ten years to run, which is only paying 10%, is paying no interest at all to the man who buys its shares at par." The sense is as good as the writing is done by. "A mine is a wasting asset and until the capital spent in purchasing, equipping and developing it has been redeemed no part of the earnings is a true profit. Flimboy int financiers long ago started to give the name of 'dividend' to a finan-

cial return of capital because by doing so they suggested a highly profitable kind of business. The tax-collector took them at their word and the industry of mining became burdened with an unfair impost. Now the income-tax of 4s. on the pound, or 20%, appears an intolerable hardship to the shareholders. Indeed it is—particularly to such as reside not in Great Britain but in a non-belligerent country. The foreign shareholders constitute an important element in the mining business of London; most of them appreciate the convenience of a headquarters in London and the efficient clerical service obtainable there. These head offices are a source of great profit to the City, both in rent and in salaries. It will be a serious matter to a number of worthy people if mining companies cease to be incubated and nursed in London. The 5% income-tax was no great burden before the War, but when it is quadrupled, with chances of further increase, the exaction becomes prohibitive. The result will be a transfer of registry wholesale unless the British authorities awaken to the position. Capital is a sensitive plant.

SPECTULATION in stocks of mining prospects is the subject of a letter appearing on another page. We are glad to give space to it, for not only is Mr. Ira B. Joralemon a mining geologist well known to us by reputation, but we appreciate the public spirit that was the motive of his warning. He states the case tersely: "A 100:1 shot is sometimes a good gamble; but a 100:1 shot for a 20:1 profit is obviously poor business." Undoubtedly the spectacular discovery in the United Verde Extension and the crop of millionaires that it sowed in Arizona has had a pernicious influence, for while the story of such a mining adventure is one to warm the cockles of the heart, the use of the incident as a sample of experience is grossly misleading. We accept Mr. Joralemon's correction of a reported discovery of rich ore. That item of news appeared in an article written by the Director of the Arizona Bureau of Mines; which only goes to show how difficult it is to obtain accurate information. On the other hand, the gossip of the plaza is interesting to many, even as unconfirmed gossip; what is needed in these matters is the drawing of a distinct line between what is gossip and what is personal knowledge. Both are interesting, but they are not to be taken in the same way. The exigencies of time prevent an editor from communicating by letter with the managements of mining companies, to confirm or correct information concerning developments underground. We regret to say that the managers are rarely permitted to give such information, and there is where the mischief begins. If the mining companies authorized their managers and superintendents to issue correct information concerning the finding or the losing—of ore in the mines, there would be less opportunity, not for speculation, but for deception. We are always grateful to any of our readers that transmit news of current mining developments and we hope that a personal invitation to do so may not be deemed necessary.

A Matter of Principle

Discussion of the Shockley episode is re-opened by a letter that we publish from Mr. Edward W. Parker, one of the members of the Anthracite Section of the Institute that took it upon themselves to censor his paper in the transactions of the Engineering Congress, as related in our issue of October 21. We welcome Mr. Parker's rejoinder as furnishing a further opportunity to make clear the facts of the case. He suggests that it is "an unpleasant incident which it were better to have left buried." We disagree; when a wrong is done to a member of our profession, it is best to defend him and to see that justice is done, in the hope of preventing a repetition. As regards the San Francisco Section, it is well to state that the committee appointed to draft the resolution on the subject consisted of Messrs. D. M. Riordan, Frank H. Probert, and F. H. Harvey. None of these needs any introduction. Mr. Harvey was chosen particularly because he has practised as an engineer in the anthracite region and is familiar with the conditions upon which Mr. Shockley had animadverted. Mr. Parker is in error in stating that Mr. Shockley refused to correct any statements in his paper; on the contrary, he agreed promptly to correct any statements that were shown to be wrong, and in his revised paper—before the censoring—he did make sundry corrections, omitting controversial matter that did not have the support of Government reports. No proof of misquotation by Mr. Shockley has been furnished by Mr. Parker or his associates in the employ of the anthracite companies. It is possible that errors did exist in a paper so full of figures, and we do not doubt Mr. Shockley's entire willingness to correct any such errors, if they had existed and if they had been pointed out. Whether the report of the Immigration Commission is correct or not, it is an official report and can be discredited only by definite statistics. Whether Nearing's book is a good or a bad one is beside the mark, since the only use of the book made by Mr. Shockley was to quote from it the statistics issued by the Secretary of Internal Affairs for the State of Pennsylvania. Whether Nearing is a socialistic villain, or not, does not arise in this controversy; the figures to which objection was made were those of an official of the State of Pennsylvania. We might as well refuse to consider Mr. Parker's figures because he is in the employ of the anthracite trust. He writes to us as the manager of the Anthracite Bureau of Information. Yes, the editor has had some experience of statistics, although not as much as Mr. Parker; he has had enough to know that of all kinds of information the statistical is the easiest twisted to suit the purpose of an argument; he knows enough to be aware that the statistics compiled for the employers in a labor controversy are just as unreliable as those prepared by the unions. For the failure to omit the statement on pages 42 and 43, the Anthracite Section is responsible; they did not ask to have it omitted and Mr. Shockley informs us that he had forgotten it was in the paper until Mr. Hohl called attention to it in our issue of October 21. Mr. Shockley did

omit all the statements to which objection was taken by the Anthracite group in their letters to the chairman of the Engineering Congress. Mr. Parker's confident assertion, now made, that "the anthracite miners are paid as high wages as the workmen in any employment requiring equal skill and application, and they are better paid than many" is probably incorrect. The Colorado operators state, on page 45 of their pamphlet: "Colorado coal miners are, and have been for many years, earning better wages than miners in any other part of the United States," and on page 5 of the same pamphlet are the figures quoted by Mr. Parker from Mr. Shockley's paper, showing that the average earnings at the two groups of Colorado mines mentioned were \$1100.75 and \$999.36. Mr. Shockley took the average of these as \$1050; and as his figure for the average earnings of the anthracite miner was \$503, it is plain how he arrived at his conclusion. Mr. Parker's estimate of the earnings of the anthracite miner is \$628, on which basis the Colorado miner earns two-thirds more. We leave it to Mr. Parker to reconcile these figures with his over-confident assertion regarding an equality of wages.

But this dispute over statistics is a herring across the trail. The San Francisco Section passed no judgment whatever upon conditions in the anthracite region—to do that it was not competent. It went on record as saying that the action of the directors of the Institute in censoring Mr. Shockley's paper was unwarrantable, and as yet we have seen no reason for questioning the justice of that decision. If the San Francisco section had been called upon to express an opinion on the action of the Anthracite Section, it is more than likely that it would have condemned the impertinent telegram sent to the Engineering Congress and the top-lofty attitude assumed by the gentlemen at Wilkes-Barre. Our own careful inquiry into the facts justifies the statement that Mr. Shockley has shown much greater sense of courtesy than his opponents and that his final agreement to withdraw the offending paragraph—which he need not have done—was marked by a consideration for the Chairman of the Engineering Congress that that gentleman should acknowledge gratefully. Mr. Parker's charge of animus and carelessness is not sustained by the evidence of the paper. A jury of his peers in San Francisco has absolved Mr. Shockley from any such indictment by the representative of the anthracite coal companies. We find an explanation of the whole controversy in the hysterical hyper-sensitiveness of the anthracite operators. We recall how the late Joseph A. Holmes, as director of the U. S. Bureau of Mines, was subjected to violent abuse because he dared, in one of his reports, to criticize the wasteful methods in vogue at the anthracite mines. The constant attitude of the operators is a watchful waiting to resent criticism. Mr. Parker, as their agent of publicity, questions the propriety of criticizing the conditions of an industry with which the critic is not familiar. Mr. Shockley has been in the anthracite region and so have others on this side of the Sierra Nevada. One does not need to live at Wilkes-Barre to understand the merits of a controversy, the chief point of which is not the rela-

tive accuracy of statistical data, but the propriety of one section of the Institute censoring a paper written by a member of another section, not in the transactions of our Institute, but in the records of a Congress by which the supposedly offending paper had been invited, accepted, edited, printed, and circulated.

British Columbia

Just north of the international line—a line on which neither fort nor soldier stands on guard—there is a mineral region of great interest and beauty. The big river that bears a name expressing the poetic impersonation of the United States has given its name also to a Canadian province that ought to be better known to the mining engineer, for it is as rich and varied in its resources as it is picturesque and healthful in its physiography. British Columbia has an area of 382,000 square miles, of which 250,000 square miles is mineralized. Since the population is only 400,000, it can be understood that much of this mountainous country has not been explored or 'prospected' with any sort of finality. That so large an undeveloped, and also habitable, area should exist on this continent is due to the geographic position of the region and the lack, until recently, of the railways so essential to organized industry. During the last five years an impetus to exploitation has been given by the building of two or three new railways, which, although designed primarily to convey the grain of the plains east of the Rocky Mountains to the western seaboard of Canada, have also afforded the facilities required for mining on a large scale. In consequence, the mining industry has undergone notable expansion. In 1915 the mineral output of the province was worth \$29,500,000, and for the first time the copper production exceeded in value that of the coal. The metallic production was the largest in the history of the Province, making a total of \$20,762,000, distributed as follows:

Gold	\$5,937,934
Silver	1,588,591
Lead	1,939,200
Copper	9,835,500
Zinc	1,460,521

The most notable advance was made in the yield of copper, which increased 26.46%. At the present time British Columbia can boast two copper mines of the first magnitude, the Hidden Creek, at Anyox, on Observatory Inlet, and the Britannia, on Howe Sound. The first of these is owned by the Granby Consolidated Mining, Smelting & Power Company, which has been working the Phoenix mines, in the Boundary district, since 1901, and is now compensating for the approaching exhaustion of its old property by developing new and larger resources in the mine on the coast, acquired in 1912. The total ore reserves now available there are estimated at about 10,000,000 tons averaging 2½% copper and about 1,000,000 tons averaging 1½% copper. The Britannia, owned by the Britannia Mining & Smelting Co., has even larger potentialities, for it owns an enormous tract of

copper-bearing schist in which it is estimated that about 17,000,000 tons of 2% ore is reasonably assured. Generalizing, it may be said that the main interest in copper mining has shifted from the interior of the Province to the coast, creating enterprises of a peculiarly attractive kind, owing to easy accessibility. Undoubtedly further search will lead to the uncovering of more low-grade but expansive undertakings in the mining belt adjoining salt water. From Britannia to Anyox the distance is 550 miles and all of it is well worthy of careful prospecting.

The lead and silver productions of the Province are derived mainly from the Slocan and Fort Steele districts. In the latter is the Sullivan mine, containing one of the big orebodies of the world, but so refractory, owing to its zinc content, that until recently it had but scant commercial value. This has been remedied by the successful introduction of the electrolytic zinc process at the Trail smelter, which, like the Sullivan mine, is owned by the Consolidated Mining & Smelting Company of Canada. The old silver-lead mines of the Slocan, especially at Ainsworth, Sandon, and Silverton, are undergoing a revival, owing to the stimulation of higher metal prices. The War, of course, has given an impetus to mining all over the Province, because the intensive demand for metals has created a good market. On the other hand, the splendidly patriotic response of the people of British Columbia has depleted the mining population and caused a scarcity of labor, corrected in part by immigration from the United States and Japan. As regards gold mining, the yield of the placer mines is relatively small, only \$770,000, but it improved in 1915, thanks to a fairly good season in the Atlin and Cariboo districts. On the other hand, the lode mines in the Boundary and Rossland districts did better and several new finds, notably the Surf Inlet, were recorded in the Coast district; but a large part of the gold comes as a by-product in the smelting of base-metal ores, particularly those of copper. As yet no extension of the Juneau belt has been traced from Alaska southward into British Columbia, but it will be strange if intelligent exploration along the Coast range does not uncover similar lode-channels containing low-grade but extensive orebodies. The coast is indented so as to furnish easy access by water to this promising belt of mineral country and we expect therefore that under the existing stimulus to the search for metals there will ensue many new discoveries, both of gold and copper. The Provincial Government is friendly to foreign capital, using that word in its technical sense and meaning American money. At the present time most of the successful mining being done in British Columbia is financed from this side of the line. For reasons into which we shall enquire on another occasion, it is a fact that British capital is now no longer conspicuous in British Columbia, the big things, with the exception of the Trail smelter and its associated mines, being controlled by Americans. Nowhere is the American given a heartier welcome. To the capitalist and to the engineer from this country British Columbia offers a fine field of enterprise; we commend it to their attention.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

A Matter of Principle

The Editor:

Sir—Two articles contained in your issue of October 21—one an editorial, the other a letter of discussion—both entitled 'A Matter of Principle,' and the protest by Mr. Shockley at the action of the board of directors of the American Institute of Mining Engineers, revive an unpleasant incident which it were better to have left buried. This is also true of the act of the San Francisco Section of the Institute, which passed a resolution apparently entirely on *ex parte* evidence and on a matter with which it was not in any way familiar.

At the time that Mr. Shockley's paper was presented before the International Engineering Congress both Mr. Norris and Mr. Ludlow, who were the only anthracite men present, protested against certain statements contained therein and desired to have them corrected. Mr. Shockley, however, treated the protests of these gentlemen with scant courtesy, refused to have any correction made of the statements contained in his paper, and evinced a decided resentment of any criticism of such statements. As they could not get him to correct his statements, their only recourse was to protest as they did to the board of directors of the Institute through the Anthracite Section.

Some of the statements made in Mr. Shockley's paper did great injustice to the operators in the anthracite region, but even that might be excused if many of the figures used had not been misquoted or misapplied. The fact of the matter is that the paper not only showed animus, but a carelessness in the use of figures to which a stronger term might be applied. I know this because it devolved upon me to try to verify some of Mr. Shockley's statements.

The report of the Immigration Commission, of which he made much use and from which he erroneously quoted, was not only more than a decade old, but was not compiled from any reliable official data. If the editor of the MINING AND SCIENTIFIC PRESS had had as much experience with statistical work as the writer has had, he would know that any Congressional Commission usually compiles statistics to suit its purposes. The MINING AND SCIENTIFIC PRESS may take my assurance of the fact that the report of the Immigration Commission was not made up of any reliable data collected from the anthracite region.

It is hardly worth while to comment on the use by Mr. Shockley of information (?) contained in Nearing's book on 'Anthracite.' Nearing was practically engaged

by the United Mine Workers of America to prepare this book in advance of the wage conference last April, and it was supposed that this publication would have great weight in fixing public opinion favorable to the cause of the United Mine Workers. It is somewhat trite to say that any act or thing has acted as a boomerang, but that was certainly the case in this instance. Nearing's book was so palpably inaccurate and irresponsible, was shot so full of holes by the reviews made of it, that I am informed it was never referred to in the wage conference. It was practically disowned by its own father. Nearing himself is now recognized as a radical of the most pronounced type and his statements should not be taken seriously by thinking people. By his own acts and utterances he has completely vindicated the action of the Board of Trustees of the University of Pennsylvania in separating him from that institution.

Both of these men, Mr. Shockley and Dr. Nearing, have presumed to write about the conditions in the anthracite region, neither of them ever having been in the region and neither having been informed as to the reliability of the information upon which they have attempted to draw conclusions and to influence public opinion.

In spite of all that has been done, however, by the anthracite section to prevent any misleading statements of this region and this industry in the Proceedings of the Congress, I note that Mr. Shockley has been able to get in one statement, which is quoted in Mr. Hohl's letter, and which is, you may take it from me, not in accordance with fact. This statement occurs on pages 42 and 43 of the report of the Congress and is as follows:

"According to the mine operators' statement, these miners (Southern Colorado) are making the highest wages of any coal miners in the United States: the annual wages for all miners in the Victor American Fuel Co. for the year ending June 30, 1913, were \$1100.75; for the same period the miners of the Colorado Fuel & Iron Co. made \$999.36; the average being more than twice that of the anthracite miners of Pennsylvania." (Italics mine).

It would be interesting to know Mr. Shockley's authority for this statement. The anthracite miners are paid as high wages as the workmen in any employment requiring equal skill and application, and they are far better paid than many.

Aside from all this, however, it seems to the writer that the action of the San Francisco Section and of the MINING AND SCIENTIFIC PRESS in attempting to pass

judgment upon a matter affecting a region and an industry with which they are not at all familiar, is not in conformity with the ethics of the mining engineering profession. If the gold-mining or petroleum-producing industries of California had been made the subject of gross injustice in a paper before such a dignified organization as the International Engineering Congress by a member from the Atlantic Coast who was not familiar with the conditions, and if the San Francisco Section had taken steps to see that the matter was corrected before its publication to the world, or, if not corrected, suppressed, it is not believed that the anthracite, the New York, or any other eastern section, would have entered objection thereto.

E. W. PARKER.

Wilkes-Barre, Pa., November 6.

Gambling in Shares

The Editor:

Sir: During a mining boom like the one we are now enjoying in Arizona, it seems to me that the technical journals have an important duty which is being overlooked. This is to try to curb excessive speculation in stocks of mining prospects, or at least to try to see that the gambling is done at odds which give the public a fair chance. A hundred to one shot is sometimes a good gamble. But a hundred to one shot for a twenty to one profit is obviously poor business. This is the sort of gambling which is now being done by those who buy stock in nearly any of the new development companies in the South west.

During the past year dozens of companies have been formed or resuscitated to develop prospects in the Jerome district and other parts of Arizona. Usually the point most emphasized in advertising these companies is the fact that they are within a mile or two of great producing mines. With possibly one or two exceptions, the very best that can be said of the prospects is that they are worth developing. Hardly one of them has a ton of ore developed, and many others expose only recent rocks which have no bearing whatsoever on any possible mineralization in the older underlying formations. It is surely reckless to value such prospects at figures much greater than the sum which must be spent in developing them. This should in no case greatly exceed half or three-quarters of a million dollars. But these new companies, instead of having a stock valuation of half a million dollars, are now selling at figures which give them a value of from two to ten or fifteen millions. These prospects, certainly, do not stand more than one chance in ten of making mines. Assuming that one in ten will make a mine worth from ten to fifty million dollars, those who buy stocks at the present prices are taking a one in ten chance for a profit of from two to five for one. This is certainly poor gambling.

It is true that, at the issue prices, many of the new companies did not have a capitalization greatly in excess of the money needed to develop them. It is the speculation since the issuing of the stock which has caused the

inflation and which will cause hundreds of people, many of whom cannot afford to throw away money, to lose tens of millions of dollars within the next two or three years. The result will surely be a great injury to the good name of Arizona and of the mining profession.

It seems to me that the technical journals can help a great deal by trying to educate the public to distinguish between a legitimate mining gamble and a gamble at outrageous odds. This may be a hopeless task when the sight of the easily won fortunes in Verde Extension and other stocks have turned the heads of so many people. If they cannot help in this way, the journals should certainly be most careful not to print untrue or exaggerated stories of the discovery of ore by these new companies. Such stories often come in articles which should be authoritative. For instance in your issue of November 1, in the article on 'Mining in the Jerome District' there is a report of a discovery of a rich ore-body in a property the management of which does not claim to have any ore whatever. The gossip of the 'plaza miners' should not find a place in a journal with a standard as high as that you set.

The managements of nearly all of these new companies are honest, though sometimes lacking in experience. Most of them are trying to find ore and not to swindle a gullible public. I wish to suggest therefore that before publishing reports of the discovery of ore by those development companies you communicate with the managers and have the statements verified. I feel sure that this precaution will prevent many people from buying stock at exorbitant prices, and will greatly help the mining industry.

IRA B. JORALEMON.

Warren, Arizona, November 8.

THE OCCURRENCE of tungsten ores, particularly scheelite, in contact-metamorphic rocks in which garnet is a prominent constituent is known in numerous places in California, Nevada, and elsewhere and is thought by many to be something quite out of the ordinary. Such, however, is not the case, for a tungsten mine of this description was successfully operated as long ago, at least, as 1898 in Connecticut. The deposit occurred at contact of limestone and schist in a zone of contact metamorphism. The minerals were chiefly garnet, epidote, hornblende and quartz. The ore averaged about 5% tungstic oxide and was accompanied by a small amount of pyrite. The milling of this material was entirely unlike anything thus far attempted in the West. The rock was crushed in breakers, passed through rolls, and then concentrated on what were known as pneumatic separators, a sort of dry concentration device. The recovery was stated to have been satisfactory and the product up to 65% tungstic acid.

THE deepest drill hole in the world is said to be one in upper Silesia where a prospect bore-hole was cut by a diamond drill to a depth of 7317 ft. This hole is 1.44 ft. in diameter at the surface, diminishing with depth to 0.157 ft. at the bottom.



PART OF THE OPEN-CUT.



VIEW FROM THE OUTCROP OF THE VEIN.

The Blue Bell Mine, Riondel, B. C.

By T. A. Rickard

While visiting the Kootenay region recently, I was a guest of Mr. Samuel S. Fowler at Riondel, and from him* obtained a number of notes on the romantic story of the Blue Bell mine, now owned by the New Canadian Metal Co., a French organization, for which Mr. Fowler is resident manager.

This lead deposit is said to have been the first exploited in the Kootenay region, the outcrop being visible from the lake, so as to attract the attention of the Indians and Hudson's Bay trappers, who worked the ore to obtain lead for the making of the bullets used in their muzzle-loading rifles. The year 1825 is given as the earliest date of such rudimentary mining and metallurgy in this locality. A veteran employee of the Hudson's Bay Company has testified that the trappers used to talk of the lead they obtained here and complained that it was so hard as to scour their gun-barrels. The presence of arsenic in the lead may have been the cause. The botanist Douglas is said to have visited the mine in 1825. In 1883 the principal claims were located.

The mine is situated on a peninsula projecting into the east side of Lake Kootenay. From the water it looks like a wooded island close to the shore. The highest point is 250 ft. above the water.

To understand the story of the Blue Bell, it is necessary to recall the early exploration of this mineral region. In 1865 gold was found in the upper watershed

of the Columbia river. The scene of these early discoveries was on French, McCulloch, and Carnes creeks, which are tributary to the Big Bend of the Columbia, namely, that part of its course north of Revelstoke, about Lat. 52° 10' N., where it ceases to flow north and makes a big curve before starting southward to the sea at Astoria, in Oregon. During 1866 there was a rush to the localities just mentioned and a good deal of gold was won. Transport by row-boats was expensive, so the Oregon Steam Navigation Company sent a Capt. White to Colville (Washington) to superintend the building of a stern-wheel steamer. This was in the fall of '67. In the following June this boat, called the *Forty-Niner*, made her first attempt to pass through the canyon above Revelstoke, failing at first but succeeding when the water had fallen. For several years White ran this boat successfully between Little Dalles (Washington) and the Big Bend country. On his last trip, however, being ill himself and anxious to obtain medical help, he tried to run the steamer down the rapids of the Dalles de Mort canyon (locally known as Death Rapids) above Revelstoke, at a time when the water was low. The steamer struck a rock and had to be beached, the crew going to Colville in a row-boat. The *Forty-Niner* was raised by Capt. A. Pingston, who ran her while any business was offered, but that was not long, because the Big Bend placer mines petered out in two or three years or proved unworkable because of boulders. She was laid-up above the Little Dalles canyon, 25 miles from Colville, or

*He, in turn, having obtained much of his information from A. D. Wheeler, of Ainsworth.

Marcus as it is now known. Later, Capt. Pingston himself died there suddenly in consequence of an accident, but he played a part in the Blue Bell story before he went over the range. It was after the steamer stopped running that Pingston made a trip, in 1871, with George Hearst, of California, to the Kootenay. It is related that in 1867 some prospectors had built a small furnace near the deposit of lead ore and that a sample of the bullion served to interest Hearst, afterward a famous mine operator and United States Senator, of whom it may be said further that his estate, through Mrs. Hearst, furnished the money for the erection of the handsome building in which is housed the Mining Department of the University of California. Another version of the story is that Hearst was shown a sample, not of bullion, but of high-grade silver lead ore, which the prospector, Henry Doan, had obtained in Colorado. The Blue Bell ore contains only $\frac{1}{2}$ oz. of silver per unit of lead. At that time Hearst was not yet a capitalist, but was acting as expert for others. He came from San Francisco with Capt. Pingston by way of Colville and the Columbia river. With him he brought an assay outfit and an assayer named Meyers, as well as the prospector who had induced Hearst to organize the expedition. This man, Doan, suggested to Pingston that the assay outfit might be lost while making a portage, but the captain ignored the sinister suggestion. On arrival at the mine, Hearst soon ascertained that he had been brought on a wild-goose chase. He could find no ore resembling the sample shown to him at San Francisco by Doan. Disgusted, he prepared to return, refusing to take Doan on his boat; he would have marooned him if Pingston had not intervened. These facts were related by Pingston himself to Mr. William Fernie, who at that time was Government agent in the Kootenay district. Another version of the story is that Doan tried to get the Indians in the party to throw the assay outfit overboard, telling them it was hoodoo. Doan acknowledged this deception after samples from the mine had been assayed on the spot. He was compelled to surrender what was left of the \$1000 paid to him on a \$10,000 bond, so that he got away with very little money. These items of information are furnished by Mr. Ben Burgunder of Colfax, Washington.

Now we come to another chapter in the story. In 1878 R. E. Sproule located all the available ground on the peninsula which covers about 140 acres. The principal claim was called the Blue Bell. Sproule, however, was not the discoverer nor was he the first locator on the hole, which had been recorded and abandoned several times before he came into the story. At that date the law required that the locator declare on oath in court that he was working on his claim. The impossibility of one man representing more than three claims was obvious. Whereupon Thomas Hammill, in 1882, filed counter claims on some of Sproule's locations. At that time Hammill was scouting for John C. Ainsworth, of Boise. George J. Ainsworth, both of Portland, Ore., were the owners of steamboat capitalists and also owners of the *Ainsworth*, the second steamer to ply between Revelstoke and the Arco

lean boundary line. The Ainsworths had secured a franchise for a railroad between the Columbia river and Lake Kootenay, the line that now runs from Robson to Nelson. To gain information previous to selecting land under the terms of their grant they sent Hammill on an exploring trip, accompanied by two other men.

In due course the conflict between Sproule and Hammill came before the magistrate at Fort Steele. The decision went against Sproule, but he was permitted to select three claims. He chose the Blue Bell, the Goldconda, and Silver King. Hammill took the Comfort and Kootenay Chief. The costs of the action, about \$3000, were taxed against Sproule and when he failed to pay the sheriff, the latter offered one-third of the Blue Bell at public sale. This interest was bought by Hammill on behalf of the Ainsworths.

Under the old law the locator was required to re-record his claim yearly, on pain of forfeiture. In the spring of '85 Sproule recorded the Blue Bell in his own name, ignoring the Ainsworth interest in the claim. Thereupon Hammill likewise recorded the whole claim in the name of the Ainsworths, ignoring Sproule's interest. On the day following Hammill's recording, Sproule threatened to kill Hammill if he set foot on the claim; the next day Hammill was found mortally wounded on the claim. He had been shot, and he died a few minutes after being found. Sproule had escaped in a boat an hour before the discovery of the crime; he was chased by the constable in another boat, and, being about to be overtaken, he landed, ascending the mountain a few miles south of Procter, which is 12 miles south-west of Riondel. Sproule was intercepted near the international boundary and underwent preliminary trial at Galena Bay, at the south end of the Blue Bell peninsula. He was found guilty and hanged at New Westminster. The Ainsworths pensioned Hammill's mother.

In the late autumn of 1884 Dr. Wilbur A. Hendryx had visited the mine and entered into an agreement with Sproule whereby Hendryx, his brother, and some parties in Minnesota and Connecticut became co-owners in the Blue Bell. When Sproule was executed they became sole owners, for the Ainsworths had forfeited their interest through the neglect of their attorney to redeem the \$3000 tax claim levied by the sheriff. Hendryx placed a steam launch, the *Surprise*, on the lake and river; he also started the work of sinking an incline on the Blue Bell lode. A portion of that incline is still to be seen near the top of the glory hole. In the year following—1885—he drove an adit from the east side and cut into a large orebody, subsequently mined as the 'vaulted chamber'. This showing prompted the driving, in 1892, of the lower adit from the lake-shore, under the direction of John R. Parks, Columbia '80, who was consulting engineer to Hendryx. Hendryx had good financial backing and became prominent in Kootenay mining affairs. He established the town of Pilot Bay and built a small coal smelter there in 1894. But the conditions were unaccusable and the plant was shut-down in 1895. Financial trouble beset him and the Blue Bell

property passed into the hands of the Bank of Montreal, which, in the summer of 1905, sold it to the Canadian Metal Co., a French organization headed by Edouard Riondel, who built a zinc-retort smelter at Frank (Alberta), discarding the use of the Pilot Bay concentrating plant and lead smelter. The zinc enterprise failed, running the company into debt, so that it was on the verge of complete collapse. In the summer of 1896 Mr. Fowler reported on the whole undertaking and became manager immediately thereafter. The present concentrating mill at Riondel, close to the mine, was built in 1907. It treats 250 tons per day and is of the conventional type: Blake crushers, rolls, jigs, trommels, Wilfley and Deister tables. The re-grinding is done in Huntington mills. These operations yield a concentrate in the ratio of 10:1, containing 48% lead, 12 oz. silver per ton, and 3% zinc, which is shipped to the smelter at Trail. The freightage is \$1.35, plus 20c. per ton for transfer from the barges.

in which the concentrate is loaded, into the railway-cars, at Procter in winter, if the arm of the lake happens to be frozen, and at Nelson in summer. The smelting-rate is satisfactory. The company is operating at a profit, increased recently by the favorable metal market. The mine is now 600 ft. deep on an incline of 35°. The deposit is a replacement in limestone, the irregular masses of ore following the bedding, with tongues projecting into the foot-wall country. This consists of pre-Cambrian sediments (underlying the Beltian series of the Coeur d'Alene) into which intrude granitic dikes, probably connecting with the Nelson batholith of granite, which is of post-Jurassic age.

Thus the story ends on a dry technical note; but the earlier paragraphs will have served to prove that the biographies of mines, as of man, are profitable reading, in so far as they convey a lesson and a warning to those that follow.

Zinc Production at Butte

The third report of the Butte & Superior Mining Co. for the current year gives the following data:

	Third quarter	Second quarter
Ore milled, tons.....	136,130	161,270
Zinc-content, per cent.....	15.5570	15.9709
Silver-content, ounces.....	6.6072	6.7041
Zinc concentrate, tons.....	37,333	45,194
Zinc in concentrate, per cent...	52.928	52.9956
Zinc in concentrate, pounds.....	39,519,432	47,901,445
Silver in concentrate, ounces...	21,500	21,8757
Recovery, per cent.....	93.314	92.989
Mining costs per ton.....	\$4.9437	\$4.4971
Milling cost per ton.....	\$2.1691	\$1.7610

The decrease in quantity of ore treated during the last term was due to an accident in the shaft in August, thereby causing the suspension of operations for 11 days. The increased cost in mining and milling is due

rate dividend was paid on September 30 together with an extra of \$5 per share.

Financial results showed the following:

	Third quarter	Second quarter
Net value of zinc concentrate at mill....	\$1,731,670	\$2,879,568
Net value of lead concentrate at mill, etc.	190,099	246,341
Miscellaneous income.....	14,757	22,772
Total net value.....	\$1,936,527	\$3,148,682
Operating cost, etc.....	988,625	1,086,653
Profits.....	\$ 947,901	\$2,062,029

Copper Output in September Quarter

Reports of several copper companies for the third period of 1916 are to hand, and include the following information:

	Chino	Nevada Con.	Ray	Utah Copper
Overburden moved, yards.....	961,617	.....	.....	1,585,963
Cost of mining, cents per ton.....	.....	.....	78.46	.....
Ore treated, tons.....	801,500	1,020,546	849,100	3,404,300
Average per day, tons.....	8,712	11,093	9,233	37,000
Copper-content, per cent.....	1.89	1.68	1.571	1.4484
Concentrate, tons.....	62,531	.....	.....	.....
Copper-content, per cent.....	16.48	.....	.....	.....
Recovery, per cent.....	.....	.....	.....	61.94
Cost of milling, cents per ton.....	.....	.....	54.99	.....
Total copper, pounds.....	20,606,723	24,585,393	19,061,727	61,079,924
Cost, cents per pound.....	8.17	8.67	10.348	6.322
Price for copper, cents.....	25.61	23.883	27.722	25.364
Total income.....	\$3,445,292	\$3,901,197	\$3,299,100	\$12,049,460
Dividends paid.....	1,957,455	1,999,457	1,182,884	4,873,470
Surplus for period.....	1,487,837	1,901,740	2,116,516	7,175,990

to the smaller tonnage treated, the constantly increasing cost of supplies, and the larger maintenance costs brought about through repairs to the Black Rock shaft.

The average price used in estimating returns on spelter for the quarter is 8.3441 cents per pound. The directors voted to increase the regular dividend rate from 75 cents per share per quarter, to \$1.25 per share, at which

Increases in production were 2,507,511 lb. by Chino, 494,372 lb. by Nevada Con., 394,063 lb. by Ray, and 12,684,995 lb. by Utah Copper. Dividends were the same in the last two quarters by Chino and Utah Copper, increases of \$199,505 and \$394,295 being paid by Nevada Con. and Ray. The amount of copper on hand, if any, is not stated.

New Scheelite Discovery

By W. H. STORNS

A new tungsten region was discovered during the past summer on the west slope of the Greenhorn mountains, in Kern county, California. One of the discoveries is near the head of Cedar Creek canyon, on the middle fork; the other is about two miles south, on Slick Rock creek, near the road between Glenville and Kernville. The region is mostly granitic, but includes several elongated areas of much altered Paleozoic sedimentary rocks, principally argillite, quartzite, and limestone. These areas are usually several hundred feet wide and 2 to 3 miles long. Along the borders of the granite and the old sediments there is often a broad zone of metamorphism, in which garnets, epidote, hornblende, secondary silica, and some other minerals are abundant. It is in these zones of metamorphism that the tungsten mineral occurs, in the form of scheelite. Neither wolframite nor hübnerite were observed at either of the places where prospecting had been done. Several holes had been sunk at various places in the district in rocks similar to those described where no tungsten was discovered, though in some of these holes veins of solid pyrite, 5 to 7 ft. thick were uncovered.

Whether these zones of contact-metamorphic minerals represent an alteration of what were originally masses of limestone, I do not know, not having had the time or opportunity to examine thoroughly the localities far from the prospect-holes that had been sunk in search of tungsten. At one place I found a zone of metamorphism nearly 100 ft. wide, consisting mostly of several varieties of garnet; a felsitic dike had been intruded into this mass and in the felsite were a few crystals of molybdenite, but no scheelite or other tungsten mineral was seen.

In the prospect holes near the head of Cedar Creek canyon, scheelite was liberally sprinkled through the garnetized mass, assays ranging from a trace up to 30% WO₃. Many of the crystals of scheelite were the size of large peas, but no solid masses of the mineral were found. The zone of garnet at this place was apparently at least 25 ft. wide, but so little work had been done and the surface outcrop was so obscure that the actual width could not be determined.

At the other locality, on Slick Rock creek, the scheelite was also associated with garnet, together with hornblende, black tourmaline, feldspar, quartz, a little pyrite and chalcopyrite, and with an abundance of pyrrhotite. This latter mineral is an unusual accompaniment of tungsten minerals as far as I have observed or heard. This hole, I was told, was originally sunk in prospecting for tin, years ago, but no tin was found. The ore, like that on Cedar Creek, was of good grade, running from 1 to 30% WO₃, but the amount of development was negligible. The vein was apparently but three feet wide, with a wall of mica schist on one side and a granitic rock on the other. It stood nearly vertical, striking

northwest-southeast. Two zones of fissuring crossed the vein at a right angle, each forming a zone of crushed material about a foot wide. These fissures were 10 ft. apart, having this small segment of good ore between them. There was no trace of scheelite in either of these cross-fissures, nor in the vein itself at or near the surface, where the sulphide minerals had been oxidized, forming a limonite cap or gossan. Evidently the sulphuric acid, freed by the oxidation of the sulphide minerals, had dissolved the scheelite, and the tungstic acid had been completely removed by leaching. However, at two or three feet below the surface the scheelite began to appear in the form of much corroded sandy crystals, which at a little greater depth were firm, well defined, and glassy. It is scarcely likely that these two discoveries are the only occurrences of tungsten in that region. Others doubtless will be found by persistent search. The district is in direct line with the tungsten belt known to extend from the vicinity of Raymond, in Madera county, south-eastward to the vicinity of Atolia, in Kern county. Along this belt tungsten ores are known to occur at a number of places between the limits indicated, though it is by no means improbable that the 'belt' will be found to extend in both directions far beyond Raymond at one end, and Atolia at the other.

In the granite areas of this region are also known veins of antimony ore, principally stibnite and jamesonite, and also veins of gold and silver ores. Pegmatite, diorite, and other intrusions are numerous in some places, penetrating both the granite and metamorphic rocks, and the geological conditions are favorable for the formation of veins. The region is heavily timbered, water is abundant, and good automobile roads cross the mountains at intervals of every few miles.

In the early days of mining in California there was an important gold region in the vicinity of Kern River canyon, and many gold mines were then developed and worked with varying success, much of the ore being high-grade. A revival of mining in this region, on both sides of Greenhorn mountain is not at all improbable, which will be stimulated somewhat by the prospecting for tungsten ore, which is likely to be carried on vigorously next summer. Winter work is entirely feasible in a camp fully established and equipped, but surface prospecting during winter is handicapped by a heavy snowfall. The altitude of the tungsten camp is about 6500 feet.

NICKEL PRODUCTION OF Canada, which means Ontario, this year is estimated to total \$23,000,000, against \$20,123,318 in 1915, and \$13,655,381 in 1914. Over 80% of the world's output comes from the Dominion, mostly from the Sudbury district. Three large companies are operating, namely, the International Nickel Co., the Mond Nickel Co., and the British-America Nickel Corporation, a new concern. The first named reduces the ore to matte at Sudbury, refining in New Jersey; the second makes matte at Coniston, Ontario, refining at Clydach, Wales; while the new company will probably reduce the ore in Ontario.



COPPEROPOLIS, LOOKING NORTH.



THE CALAVERAS COPPER CO.'S MILL.

Flotation at the Calaveras Copper—A Simple Flow-Sheet

By Hallet R. Robbins

INTRODUCTION. The Union mine is situated in the foot-hills of the Sierra Nevada in the extreme southern part of Calaveras county, California. The town of Copperopolis, with a present population of about 600, has grown up around the mine, and is reached by road from Angels Camp, 12 miles; Stockton, 42 miles; or Milton, 17 miles. The mail is carried by automobile-stage daily except Sunday over the last route, and there is also regular auto-stage service from Stockton. Surveys have just been completed, and construction is about to be started, on an extension of the Southern Pacific railroad from Milton to Copperopolis, two views of which are shown at the top of this page.

This is one of the oldest and most interesting metal mines in California. It was discovered by placer miners in 1859, and soon afterward one portion of the lode was acquired by Frederick Ames of Boston, and another, called the Keystone mine, by Oliver Ames. The Union Copper Mining Co., organized by the former, subsequently absorbed the Keystone property, as well as several smaller holdings on other portions of the lode. Operations were conducted by the Union Copper Mining Co. on a large scale. During each of the years, 1865 and 1866, about 23,000 tons of ore, averaging over 20% copper, was shipped to Swansea, by wagon to Stockton, by river-boat to San Francisco bay, and finally by sailing-vessel around the Horn. A stone blast-furnace was erected and operated on second-class ore averaging 10% copper, using charcoal as fuel. The matte was shipped to Swansea. No statistics are available as to the tonnage treated in this smelter.

The fall in the price of copper following the Civil War, as well as the high cost of transportation, caused the mine to be closed-down in 1867, in which condition it remained until 1887, when there was a renewal of activity at the property, culminating in the erection, in

1891, of another blast-furnace smelting-plant, which ran about two years, and produced 150,000 tons of slag.

Operations were again suspended in 1893, the mine remaining idle until 1905, when a gravity-concentration mill and a third smelter were built. The mill did not run longer than a week or two at this period, but the smelter ran about two years on first-class ore. Heap-roasting was practised, the calcine being smelted in a 50 by 7 ft. reverberatory furnace, producing a 50% matte, which was shipped to a refinery at Chicago.

The panic of 1907 caused another suspension of operations, lasting until 1909, when the Calaveras Copper Co. was organized and took over the property on a bond. The smelter was re-built, and two 20-ft. six-hearth McDougall roasters were erected. The plant proved unworkable after two weeks' trial, and then a 40 by 120-in. blast-furnace was built, but it ran for two weeks only. Converting equipment was purchased and delivered, but never installed. The mill was operated intermittently at this time, but did not make over a 50% saving.

In September 1914 a capable and efficient manager in the person of S. M. Levy, of Salt Lake City, was appointed, under whose guidance, with the assistance of E. C. Trask, mill foreman, D. C. Williams, mine foreman, and Frank W. Royer, consulting engineer, the property has been firmly placed on a paying basis, and has become one of the greatest promise.

THE OREBODY is a replacement in amphibolite schist; it is from 100 to 200 ft. wide, with slate hanging wall and serpentine foot-wall. The valuable minerals are chalcopyrite, containing no gold or silver, and, near the surface, red and black oxides of copper. The lode is free from serious faulting, it strikes north-west, dips 61° north-east, has been fully developed for a length of 1500 ft. and to a depth of 800 ft., and is known to persist over a length of three-quarters of a mile. There is every

indication of persistence in depth, as well as to a greater distance along the strike.

The most striking peculiarity of the ore is the association of a large amount of barren pyrite with the chalcopyrite. This is the explanation for the many failures to exploit the mine, for when gravity concentration was attempted, the pyrite was saved, while the chalcopyrite was largely slined and lost.

THE MINE is opened by two working-shafts, the Union and the Discovery. The former is 800 ft. deep, vertical to the 5th level, and on an incline of 63°, following the lode, from there to the bottom. It was sunk in the 'sixties, and is equipped with a wooden head-frame, 35 ft. high, and with a double-drum hoist with both steam and electric drive.

The Discovery shaft is in the lode, on the hanging-wall side, and is now 400 ft. deep, measured along the 61° incline, but is being connected with the 9th level by raising. It is equipped with an excellent steel head-frame, 80 ft. high, erected in 1902 at a cost of \$10,000, and good for four compartments, though the shaft now has but three; and with a steam-driven double-drum hoist, good for 1500 ft., and with a 1500-cu. ft. compressor driven by a 275-hp. motor.

The stopes are 15 to 30 ft. wide; the shrinkage method is followed, at a cost of 50 cents per ton. The total cost of mining, including timbering, hoisting, development, etc., with the present daily production of 200 tons, is \$1.50 per ton. It is expected that this will be reduced to \$1.25, as soon as the production is increased to 500 tons per day, which is the maximum output expected at present.

The force employed includes 2 shift-bosses at \$4; 10 machine miners at \$3.50; 4 timber-men at \$3.50; 4 timber men's helpers at \$3.25; and 22 shovellers at \$2.75.

Ingersoll-Rand stopers are used for stoping and raising; jack hammers for sinking and block-holing; and Denver Drednought water drills in the drifts.

The mine is considerably wetter in winter than in summer. In the wet season, one 1½ by 7 in. triplex pump is operated 24 hours daily, raising all the water made by the mine, from the 8th level to the surface. In the summer it is run only six to seven hours per day.

FLOTATION. Experiments began in December 1914; in February 1915, the so-called little mill was started on accumulated tailing from the old gravity mill, containing about 1.5% copper. The equipment consisted of one Huntington mill, grinding through 50 mesh, a mechanical agitator, a pneumatic flotation cell, making a final tailing and a rough concentrate, and a Wilfley table, making a final concentrate and a middling that was returned to the Huntington. In May 1915, the treatment of accumulated tailing was discontinued, the 'little mill' after that date handling 25 tons per day of undersize from the 4 in. trommel at the pitting plant. The oversize, after the first class ore had been picked out, was treated in the 'big mill,' which was the old gravity mill with some experimental flotation equipment, handling 60 tons per day, with much the same flowsheet as in

the little mill, so that further description is not necessary.

The results of this operation indicated that from a mill-feed assaying 3% copper, 28% iron, 20% sulphur, 20% silica, and 10% alumina, there would be obtained a concentrate assaying about 19% copper, 30% iron, 35% sulphur, and 6% insoluble, with a ratio of concentration of 7:1, and a recovery of 90%.

These operations also indicated that the most efficient oil was Yaryan steam pine-oil, and that mechanical agitation of the pulp before flotation was necessary for the best results.

The old gravity-mill, which was housed in a well-built and substantial steel-frame building, was then further re-modeled, and in March 1916 operations began according to the flow-sheet shown in Fig. 1. These operations have been remarkably successful.

PRESENT PRACTICE. The extreme simplicity of the plant, and the entire absence of any gravity concentration are very striking. The ball-mill has a normal capacity of about 8 to 9 tons per hour. The reduction in one mill from 3-in. size to a product 90% of which passes 80-mesh would not be economical in a large plant, but in a small one the simplicity of the arrangement is commendable. The mill is driven through a counter-shaft, by a 150-hp. motor, at a speed of 23 r.p.m. The normal power consumption when running is 120 hp. Forged steel balls, 5 in. diam., are used, the consumption being 0.5 lb. per ton of ore ground. Of the total product 40% is finished through 80-mesh, the remainder being returned by the classifier. The mill has given reasonable satisfaction, the most serious difficulties being blinding of the difficultly-accessible grating, leakage around lining-bolt holes and dropping-out of lining-bolts, and a peculiar ailment, not as yet fully diagnosed, but probably due in part to the wear of the lining, that at times has caused the capacity of the mill to drop practically to zero. When the mill was opened on such occasions the ore and balls were found in quite separate masses. Increasing the speed from 21 r.p.m., as recommended by the makers, to 23 r.p.m. proved beneficial in minimizing this trouble.

Difficulty has also been encountered in the buckling of the lining segments, which are the full length of the mill, thicker on one edge than on the other, in order to form steps to lift the balls and cause them to cascade properly through the charge of ore. They are held by three bolts in a line along the centre of each segment. The edges of the segments draw away from the shell, and the lining requires to be discarded and renewed when only about half the metal has been worn away. Similar troubles have been reported at other plants, and it is my belief that they may be overcome by the use of lining in full annular sections, wedged in place, with no bolt-holes whatever through the shell. Such sections may be secured from the Lehigh Car Wheel & Axle Co., and are being tried by the Utah Copper company.

The oil adopted as standard in the present operation, after exhaustive experiments, is the No. 400 crude wood-

erosote produced by the Pensacola Tar & Turpentine Co. The No. 350 crude pine-oil produced by the same company was recently tried on a 24-hours run, with a marked increase in the value of the tailing, and a decrease in the grade of the concentrate. A mixture of equal parts of No. 17 hardwood-erosote, and No. 20 coal-tar erosote, furnished by the General Naval Stores Co., has given the best results of any oil other than that regularly used.

The oil is all fed into the ball-mill feed-box from a

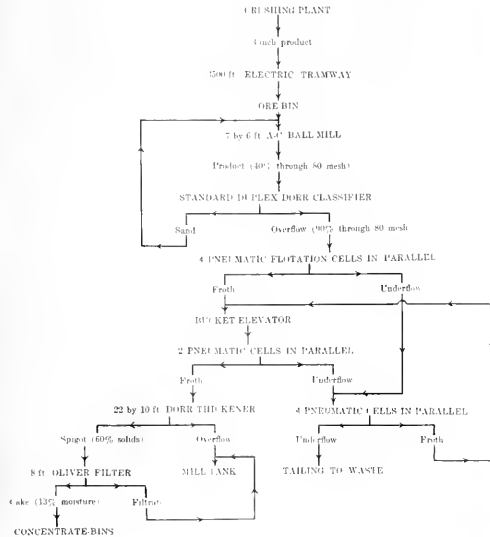


FIG. 1. FLOW-SHEET.

15-gal. zerolene can, fitted with a special bronze stop-cock. The consumption averages 0.3 lb. per ton of ore. It is so well mixed and agitated in the ball-mill that neither mechanical nor pneumatic agitation before flotation is found of any benefit whatever.

The return of the filtrate from the concentrate-filter, and of the overflow from the concentrate-thickener has been found not only to decrease the amount of oil required, but also to effect a closer saving than is possible otherwise, no matter how much oil be used.

The flotation-cells are made locally from Oregon fir, protected with P. & B. paint, at a cost of about \$100 each, complete. They are of the type for which J. M. Callow has had process and apparatus patent applications pending in the United States for some time. The porous bottom differs from that used by Mr. Callow in the cells he has built. It is composed of eight separate shallow cast-iron pans, placed side by side along the sloping bottom of the cell, each covered with a multiple-canvas, fastened around the edges only. Screens or grids, similar to those used by Mr. Callow were tried but proved both unnecessary and objectionable.

The outside length of each pan is a trifle less than the inside width of the cell. Two $\frac{3}{4}$ -in. pipes are screwed into

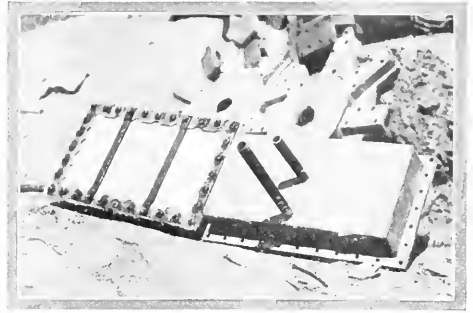


FIG. 2. COPPEROPOLIS AIR-PANS.

the bottom of each pan, and pass through holes bored in the wooden floor of the cell. One is connected by means of an easily-removable length of hose, to the air-main manifold, and the other is fitted with a plug-cock, nor-

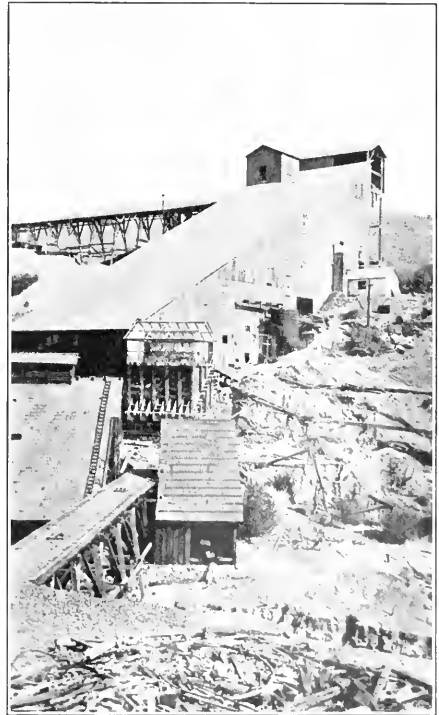


FIG. 3. THE MILL.

mally closed, but opened periodically to blow out accumulations of water in the pan.

When it is desired to remove a pan, the air-hose is disconnected, and the plug-cock unscrewed, when the pan may easily be lifted from the cell. When the cell is

in operation, the holes through which the air and water-blow-off pipes pass, are caulked with oakum. This form of air-pan was an original development at Copperopolis, but resembles that developed originally at McGill, Nevada, and used in the pneumatic flotation-cells of the Nevada Consolidated Copper Co. A photograph of two of the Copperopolis air-pans, one right-side up and the other bottom up, is shown in Fig. 2.

A detail drawing of the flotation-cell as a whole, from which one may be built by any competent carpenter, is shown in Fig. 4.

Air is furnished at $5\frac{1}{2}$ lb. pressure by a Connersville blower. The consumption is about 80 cu. ft. free air per min. per cell. Each cell is emptied once per day and the surface of the canvas is washed off with a hose. The canvas lasts several weeks, and when a renewal is necessary, it is effected quickly by removing the pan in the manner described, and replacing it with one already freshly clothed.

The air-supply is not filtered, but I believe it is good practice to do so in all cases where porous media are used in flotation-cells. During the past two years I have visited nearly every flotation plant of consequence in the West, and have seen no pneumatic cell frothing so smoothly and evenly as those at Copperopolis.

Some interesting experiments have been made in heating the thickened concentrate in the filter. At some plants where this has been tried, it was found possible to make a cake of double or treble the usual thickness, with no increase in the moisture content. This is probably due to the heat decreasing the viscosity of the oil in the pores of the filter-canvas.

The results of the operation of the plant may be appreciated from the following assays of composite samples for the month of June 1916:

	Copper, %	Iron, %	Insoluble, %
Heading	2.15	20.4	37.0
Concentrate	11.40	29.5	14.9
Tailing	0.09	18.0	43.4
Rough concentrate	8.0	...	...
Cleaner tailing	2.0	...	...
Ratio of concentration, 7.1			
Saving of copper, 26.4%			
Saving of iron, 30.2%			

It will be interesting to compare these results with those obtained in the old gravity mill, the concentrate from which assayed 5.8% copper, 35.5% iron, 37.4% sulphur, 12.7% silica, and 6.5% alumina. The heading ran 2.1% copper, the tailing 1.5%, the ratio of concentration was 6.6:1, and the percentage of recovery of the copper was 50.

At present the tailing normally assays a 'trace,' which means not over 0.01% copper, a remarkable record, but I believe that any ordinary chalcopyrite ore may be treated by a similar method with similar results. I have myself made a mill run at this plant with an ore containing 1.38% copper as chalcopyrite, and 22% iron, mostly as pyrrhotite. The grade of the concentrate was 7.32% copper, the tailing 0.07%, the ratio of concentra-

tion 5.53:1, and the recovery 95.9%. I have in mind two plants operating under license from Minerals Separation, treating simple chalcopyrite ores, that do not contain nearly so much pyrite as the Calaveras ore and therefore should be much easier to concentrate. Each of these plants uses a more complicated flow-sheet than the Copperopolis plant, and is proud of a tailing containing 0.15% copper. This is eloquent evidence concerning benefits accruing to licensees of Minerals Separation from the superior (?) metallurgical knowledge placed at their disposal by that syndicate.

OPERATING COSTS. These are shown by the following figures taken at random from the company's books, representing actual costs for the week ended July 7, 1916:

Power, 184 hp. per day, at 0.825c. per kw.-hr.....	\$191.25
Operating labor, 70 shifts, at \$3.25.....	228.75
Superintendence, repair, and extra labor.....	137.48
Supplies of all kinds	132.40
	\$689.88

On a normal tonnage of 192 per day, this is equivalent to 51.4c. per ton.

TRANSPORTATION. Incoming supplies and outgoing concentrate are hauled between Milton and Copperopolis by wagon with trailers, drawn by 14 horses, and carrying about 12 tons per load, at a contract price of \$3.25 per ton, or about 20c. per ton-mile. The road is very rough, and attempts to use auto-trucks have resulted in failure thus far. During the rainy season the condition of the road is so bad that it is impossible to do any hauling; it has been necessary even to suspend operations during that period. Rail-freight on the concentrate is \$1.25 per ton from Milton to the smelter on San Francisco bay, and \$6.40 per ton to Tacoma, where this product is now shipped.

PICTURE OPERATIONS. There has just been installed an 8-ft. by 30-in. Hardinge ball-mill on trial, under a guarantee by its manufacturer that it will grind 25% more ore, with 25% less power than the 7 by 6-ft. Allis-Chalmers mill. It should be remarked, however, that the price of the Hardinge mill is \$1800 more than that of the Allis-Chalmers.

It is the intention of the Calaveras management to make careful competitive tests of the two mills on the same ore, and under identical conditions. It is hoped that the results of these tests may be presented to the readers of MINING and SCIENTIFIC PRESS by E. C. Trask, in the near future, if the Editor will risk hurting the feelings of one of his advertisers, and it is believed that the figures will be of value to all those interested in ball mills.

The two ball mills together, whether operated in series or in parallel, are expected to have a capacity of about 500 tons per day, and 10 additional flotation-cells, with the necessary blower, are being installed to take care of the increased tonnage. The present Oliver filter (8-ft. diam. by 6-ft. face) is to be supplemented by one of the same face but 11½ ft. diameter. This is expected to

handle 50 tons per day of thickened concentrate, reducing the moisture to about 12%, with a cake half an inch thick.

It is proposed to convey the concentrate from the thickener to the filter in a 5-in. pipe through the centre of which there will be a 1-in. steam-pipe. This will avoid diluting the thickened concentrate-pulp by condensed steam.

It is estimated that no more labor will be required to operate the plant when treating 500 tons than at present. Assuming the power and supply costs to increase propor-

tionally with the tonnage, an average weekly cost would be approximately as follows:

Power, 479 hp. per day, at 0.825c. per kw.-hr.....	\$497
Labor, as at present	366
Supplies	690
	<hr/> \$1553

This is equivalent to 44.4c. per ton, but it is believed the actual cost will not exceed 40c. On the completion of the railroad, the capacity of the plant may be still further increased by the installation of a third ball-mill, for which room is yet available in the old mill-building.

The total capital expenditure for converting the old gravity-mill into a highly-efficient flotation-mill of 500 tons daily capacity will be less than \$50,000. A new mill built according to this flow-sheet should not cost much, if any, more, as the figure noted includes the net cost of considerable experimenting, and the dismantling of the entire equipment of the old mill, amounting to as much as a new building would cost under ordinary circumstances.

Without wishing to draw invidious comparisons, it is interesting to note that the National mill in the Coeur d'Alene, built to treat 500 tons per day of a simple

chalcopyrite ore, cost \$153,000, and has never made so close a saving as the Calaveras plant, and cost about the same to operate as the latter with its present small capacity of less than 200 tons per day. Of course, much less was known about flotation when the National mill was built than today.

Messrs. Levy and Trask are modest as to their achievements, but rumors of the excellent results they have accomplished have traveled widely, and the plant has been a Mecca for metallurgists from all parts of the country. Each visitor has departed with a pleasant impression of

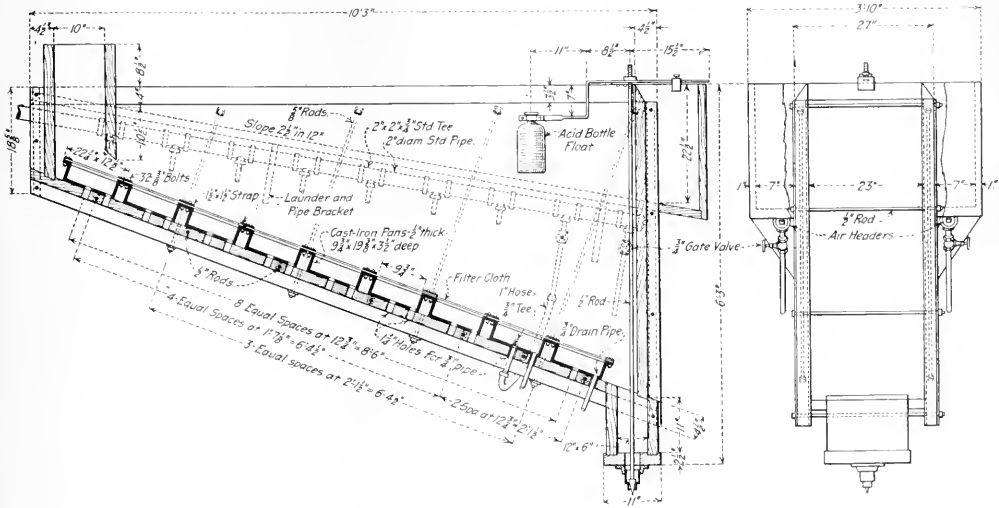


FIG. 4. DETAILS OF FLOTATION-CELL.

the courtesy with which he was received and the freedom with which all desired information was made available.

COPPER ORES occur in beds of sandstone, both red and gray, in Utah, Arizona, and New Mexico. Some of the deposits are of considerable magnitude and commercially valuable. In New Mexico several of these unusual copper deposits have been worked on a commercial scale and have afforded, in the aggregate, a large amount of copper, though usually the deposits are small and low-grade. The copper occurs primarily as chalcocite in small disseminated grains which oxidizes to malachite and azurite, and to a less extent to cuprite. The deposits of New Mexico, which have thus far proved to be the most valuable, occur in the Red Beds (both Triassic and Permian) and usually at no great distance from underlying crystalline rocks—granite and schist of pre-Cambrian age, in which copper occurs. These copper-bearing sandstones are not in the least metamorphosed, even by the infiltration of secondary silica, and they are not intruded by igneous rocks of any description. Often they are practically undisturbed by folding, nor have they been crushed or altered to a condition unlike that of the other strata with which they are associated.

Strontium Nitrate: A New Industry

By Donald F. Irvin

The active efforts made in sundry branches of the mineral industry, such as tungsten, potash, and the metals used in the ammunition trade, do not cover the entire field of opportunity created by the War. There are other products, hitherto almost unknown to the public, that have increased several hundred per cent in price: an example in point being strontium nitrate, which is produced from the mineral celestite, strontium sulphate, and is used as a necessary ingredient in pyrotechnics.

The valuable property of this chemical is the intense red color it produces in fireworks or signals. A large part of the total annual production is used in the manufacture of railway signal-fuses and marine signals, a railway-signal company being the largest single consumer in the United States.

While in no sense an explosive, it decomposes quickly, and is subject to a high risk-rate in warehouse-charges.

Prior to 1914, the American market for this chemical was dependent mainly upon European sources, and prices at New York were about 8 to 8.5 cents per pound. How large a proportion of the total business was done at that price it is difficult to ascertain.

The total consumption in the United States is stated, on good authority, to have averaged above 5 tons daily, and since the commercial complications wrought by the War, the price, *f.o.b.* New York, has mounted rapidly, until in June 1916, the figure quoted in trade journals was nominally 40 to 50c. per pound.

This figure, in common with those for other high-priced War commodities, is not 'pegged'; it denotes hope rather than accomplishment. The high quotation represents the purchase of less than ton lots by consumers in a small way, to meet their immediate needs, and is not a criterion of the prices that govern transactions on a larger scale. These prices, representing the actual return to the manufacturer, are the only basis for the true estimation of the possible profit.

A recent investigation of the manufacture of strontium nitrate in Southern California disclosed two new plants using local raw materials on a small scale.

References to the metallurgy of strontium, as made by Thorpe, Watt, and other authorities, concern themselves chiefly with the production of strontium hydrate, which is widely used as a clarifying agent in the beet-sugar refineries of Europe. Strontium salts are made cheaply in Europe, where there are widely distributed deposits of the more desirable strontianite, as well as celestite, the sulphate.

Clarke's 'Data of Geochemistry' mentions the occurrence of celestite in the great saline deposit of Stassfurt, Germany; it is also interesting to note that it is found at Searles lake. Hence the small local enterprises above-

mentioned were based upon the improvisations herein described, and did not attempt to emulate the elaborate practice of the large and long established European reduction-plants.

It is evident that the limited possibilities of consumption, and the fact that the increased price is due to transient conditions, does not induce substantial investment. Amortization rates should be high, as a measure of prudence. The 'reducing-balance' method of calculating depreciation, as described by R. S. Lewis in a recent issue of the MINING AND SCIENTIFIC PRESS, is hardly rapid enough to provide for a sufficient writing-off in this case.

Bulletin 540-T of the U. S. Geological Survey enumerates various deposits of celestite in the Western States, and one of these (at Ajo, Arizona, near the New Cornelia Copper Co.'s mine) supplied ore for one of the nitrate plants at Long Beach, California. The other plant, at Los Angeles, obtains its ore from Southern California, out of a deposit not mentioned in the Bulletin quoted. This deposit is in Imperial valley, about 40 miles by wagon-road from the Southern Pacific Railway, and therefore involves wagon or motor haulage.

Like most celestite deposits, this orebody was the result of precipitation, and is underlain by gypsum; in fact, it is said to have been first located for the sake of the gypsum itself. Mining methods are extremely simple, as the ore is removed from the surface without more labor than picking up the broken fragments with which it is strewn. The ore is finely crystalline, generally white, and on fresh fractures has an almost pearly lustre. Its high specific gravity considerably reduces the volume of material handled, per ton treated, as compared with ordinary ores of silicious character.

Methods of treatment at both of these plants are essentially the same, as the Long Beach plant derived its methods from the Los Angeles plant, which is some months older, and the same general description will suffice for both. The essential steps involved are the reduction of the sulphate to the sulphide; dissolving of the sulphide, and the nitration of the sulphide solution, forming strontium nitrate solution, which is then evaporated.

The first step is most important, and likewise most difficult; the factors affecting it are not entirely at the ready control of the operator, nor are unfavorable ones quickly recognized. Reduction is performed by the action of finely powdered carbon in the presence of heat.

Apart from the proper choice of a furnace, it is necessary to have an easily regulated fuel, and temperature-control is indispensable.

Dissolving of the sulphide, the second step, would be

simple, if the reduction were complete, as there would then be a completely soluble charge, and no residue to wash. As it is, there is always a considerable amount of unaltered celestite in the furnace charge, which must be separated from the pregnant solution, obtained by the digestion of the roasted ore.

The result of dissolving the strontium sulphide in water produces not only a sulphide, or sulph-hydrate solution, but also, a precipitate of hydrate crystals, which are re-soluble only at a high temperature. While this affords a convenient way to remove rapidly a part of the strontium from solution, it is also a nuisance in that crystallization occurs upon and in everything prior to arrival at the proper stage for removal, and much care is needed to prevent the crystals from mingling with the discharged residue and clogging the pump-lines, in the further course of the process. Jacketed pipe-lines and a supply of live steam when needed will avoid much of this trouble.

As is customary in leaching processes, the end-washes of one cycle, which are low in dissolved material, may be used to make up the first decantation on the next cycle, and the water needed to make up the bulk lost by evaporation is added as the last decantation.

In the end, all solutions are sent to the nitrating-tank, and the washed residue from the furnace-charge, after solution is effected; much reduced in amount and with a small loss in dissolved value (which is chiefly due to its small bulk, and not to specially good technique) is stacked.

Filtration in the accepted sense, including washing of the cake, is not practised; possibly, because of the small quantity handled.

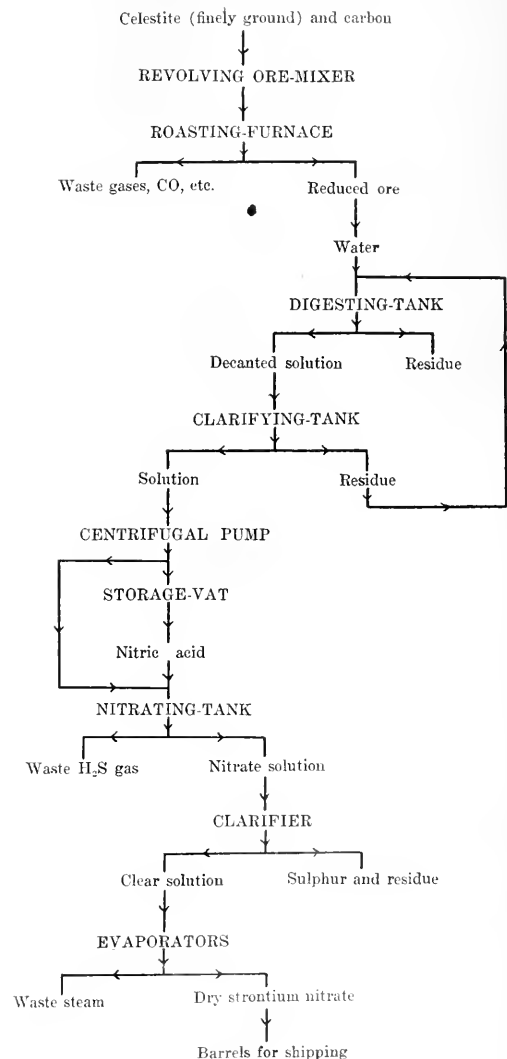
Nitration is effected by direct use of nitric acid and is accompanied by a steady and copious evolution of H_2S ; the disposal of this objectionable and harmful gas has been the subject of various expedients, which have succeeded in eliminating the bad effect upon the workmen and decreasing the complaints made by residents in the vicinity.

The lid of the nitration-tank was provided with a water-seal, after the manner of a gasometer, and the gas was drawn therefrom by a suction-fan, which discharged it through a pipe outside the building. At the point of discharge, is a small pilot-light, whose function is to ignite the H_2S as it reaches the air, burning it to SO_2 . The latter gas causes less complaint by the neighbors than when H_2S was discharged.

The nitrate solution is clarified after acid treatment, removing any extraneous material and any free sulphur that may have separated out during nitration, and then the clear solution is evaporated in open vats. No vacuum-pans are in use; chiefly because of the small size of the operations, but they would undoubtedly be much more effective than the open pans now in use, as regards economy of fuel and time. The reduction in temperature also would tend to prevent overheating of the nitrate, which is decomposed at a comparatively low temperature. When open pans are in use, it is well to dry over a steam-

or water-bath. The dried salts are screened and packed in wooden barrels for shipment, providing against injury from moisture.

Comminution of the crude ore is done in a custom-milling plant at Los Angeles, the process requiring tube-



FLOW-SHEET. THE WATER AND NITRIC ACID JOIN THE MAIN LINE OF FLOW FROM ASIDE.

milling without use of water. The extraction obtainable, as in most metallurgical operations, is affected by the scale of the work and the choice of equipment, as well as the general process. In the method described, on a nominal rating of 1 ton of ore treated in 24 hours, the net extraction may reach 70% of the possible. In this connection, it must be remembered that the chemical re-

actions alter the weights of the strontium salts derived from the original unit of celestite.



or 100% extraction of strontium nitrate, represents 1.14 times the weight of the original celestite, and 70% extraction on a ton of celestite would be: $2000 \times 1.14 \times 0.70$, or 1596 lb., which is 79.8% of 2000 lb.

Occasionally higher extractions than those mentioned have been observed, but are not frequently obtained in the routine of operation; without doubt, a net extraction of 75 or 80% could be obtained with adequate equipment.

While there is much which, to the casual glance, may seem crude and ineffective in these small plants, second thoughts reveal the underlying intent to achieve a profit in the least possible time, while incurring the least financial risk.

Unstable market conditions, of unknown duration, do not justify substantial equipments or the refinements of processes found in modern concentrators or cyanide plants, which are based upon large and persistent ore-bodies.

After all, since mining and ore-reduction is a commercial affair, conducted for purposes of profit, a scheme of treatment that involves loss in residue, and which is foreign to the trained metallurgist's conception of 'good practice,' may really be highly economical in the end. This observation is trite, but always worth repetition, when considering the number of costly and unprofitable reduction plants, the failure of which has been due largely to the neglect of this very principle.

The calendar has confuted so many amateur and professional forecasts on the duration of the War that any observations on this subject are dangerous. Yet upon this duration depends the measure of prosperity that is possible for the mineral industries that have been specially fostered by War conditions. It is a reasonable belief that serious competition on the basis of antebellum prices is not practicable where the costs due to raw materials, labor, and freight to market are as high as they are for the Californian strontium nitrate plants. The largest single item of cost is that of acid, and a substitute for that reagent would mean great economy. This would appear to be attainable if it were feasible to use crude sodium nitrate in a decomposition role. A similar plan is said to be in use in European nitrate plants, but details are not known. Even if the theoretical details were suitable for a small plant, this method would not be commercially feasible, owing to the difficulty of completely and economically removing the highly objectionable sodium content, which affects the color of the flame of the firework or signal.

The same difficulty prevents a successful commercial application of the use of soda ash in the reaction



with subsequent nitration of the carbonate by nitric acid.

This method is attractive in its apparent simplicity, which avoids the need of roasting, and is mentioned in

Bulletin 540-T, but the complete removal of sodium is attended with so much difficulty and expense, that it cannot be seriously considered in a small plant. Repeated and careful washes with distilled water fail to remove the sodium or to prevent the sodium-yellow from masking the strontium-red in the color of the flame.

Assuming that after the War, prices will resume their former level, which is of course, a debatable point, it is reasonable to foresee, meanwhile, possibly a year of satisfactory business for the nitrate plants. Those already established, with an assured supply of satisfactory ore and well-designed plants should by that time have been able to amortize their modest capital charges and amass a reasonable profit, if their selling agencies have been well chosen; an equally important condition.

THE superintendent, T. W. H. Shanahan, of the Mint at San Francisco reports the following business during October:

Bullion received:		
Gold	Fine ounces	Value
Australian gold	5,039.981	\$ 104,185.65
Sovereigns	235,377.738	4,865,689.69
Other sources	284,546.083	5,882,088.63
Total	524,963.802	\$10,851,963.97
Silver		
Coin for re-coinage	353,753.53	\$489,032.00
Fine silver	301,674.90	205,264.71
Other sources	112,104.64	75,509.32
Total	767,533.07	\$769,806.03
Fine gold bars sold	50,505.966	\$1,044,050.97
Coinage executed		Value
Pieces		
Dimes (new design)	1,450,000	\$145,000
Dimes (old design)	3,720,000	372,000
Nickels	3,200,000	160,000
Cents	6,400,000	64,000
Total	14,770,000	\$741,000

Coin, bullion, etc., on hand at close of business on October 30 was:

Gold certificates	\$ 180,000.00
Gold coin	30,071,265.00
Silver coin	62,013,757.80
Minor coin	53,752.67
Checking balance, U. S. Treasurer	16,301,407.04
Gold certificate bars	231,936,641.73
Gold bullion	84,457,479.01
Silver bullion	2,223,987.78
Total	\$427,248,291.03

IRON PYRITE in zinc sulphide concentrate is a nuisance, and the U. S. Bureau of Mines at Salt Lake City has devised a process to remove the interfering mineral, as follows: The method consists of treating the mixed sulphides in a reducing atmosphere at 600° C. The pyrite loses one atom of sulphur under these conditions and is reduced to a form that will react with dilute sulphuric acid, while the zinc sulphide is resistant to the acid. In this way the iron can be removed, making a marketable zinc product.

Smelting at Anyox and Grand Forks, B. C.

In the annual report of the Granby Consolidated Mining, Smelting & Power Co. for the year ended June 30, 1916, the superintendent of smelters, W. A. Williams, gave the following details concerning the plants that reduced a total of 1,929,205 tons of ore:

The second year of operation at the Anyox plant shows a decided improvement over the preceding period.

The works operated 1,167.43 furnace-days out of a total of 1414. On account of power-shortage during the winter months 141 furnace-days were lost, on account of ore-shortage 2 days, smelter strike 11 days, mine strike 5 days, making a total of 159 furnace-days lost for reasons not attributable to smelter troubles. An average of 3.2 furnaces out of four was in blast.

On the lower or tapping-floor a great many problems, incidental to handling a large tonnage of corrosive-molten material, have been solved, which has all tended toward the lengthening of campaigns. The molten material dealt with aggregated 250,000 tons.

The charging-system was changed this year to Anaconda type charge-cars, which dump the ore into pockets, the charge being pushed into furnaces by plows operated by compressed air when needed. This has been a decided improvement over the old method, and has been the chief aid in extending the length of campaigns.

No. 4 furnace, which has a shaft depth 5 ft. greater than the original furnaces, was operated 10½ months. It was watched carefully to see if the increased depth was an improvement. There seems to be no gain in the grade of matte, increased tonnage, or percentage of coke used; however, there does seem to be some gain in the length of campaign, and reduced crust formation due to the increased drop of charge. For this reason, if another furnace is erected, it will be made the same as No. 4, but there is not sufficient advantage gained by the increased depth of shaft to warrant changing the old furnaces to conform to this height.

In the smelting of Hidden Creek ores an effort was made to keep to the proper proportion of No. 1 and 2 orebodies, both as to quantities and analyses. As regards tonnage, there was smelted approximately equal parts of No. 1 and 2 ores, but these were a little low in silica. The average of the total orebodies will be somewhat higher in silica than the average analysis for the year 1915-'16. As regards copper-content, the ores are about the average of the whole body.

The conclusion was arrived at that true pyritic smelting cannot be done with the main ores as was done at first, that is, with low coke and no fluxes. This can be done at times, but not frequently enough to say it is the practice. The proportion of free SiO_2 is small, most of it being present as combined silicates. The Al_2O_3 is also high, and will probably exceed in the total orebodies the average for this year. It is necessary to use fairly high coke and limestone as flux. So far, the ores coming to the smelter have varied greatly in the silica-content from

lot to lot. This has created a tendency to uneven running, and necessitated a slightly greater quantity of coke and flux than would have been used otherwise. There is no remedy for this condition until the mine is opened more, or until such time as a sorting-table and screening-plant are installed.

It has not yet been feasible to make a converter grade of matte in the first smelting operation, as the degree of oxidation is low, and the matte-fall from the ore smelting is too great for the converters to handle. Therefore, one furnace was used practically throughout the year as a re-grading furnace, which means that three furnaces were operated smelting green ore, while the fourth was used for re-grading matte. The better method would be to take all the matte straight to the converters, irrespective of grade, and convert direct. This would increase the tonnage of green ore, and tend to lower costs all around, and, at the same time, help recoveries. The reason that this practice is not being followed at present is lack of converter-capacity.

The quantity of ore per furnace-day has increased from 630 to 692 tons, and total charge from 846 to 929 tons. During the year, 88,853 tons of foreign ore was smelted, which means that one blast-furnace was used 35% of its time for the total year in the smelting of this ore to the exclusion of Hidden Creek ores, and that higher cost of mining resulted, due to a lesser tonnage shipped from the company's mines. There is 46,480 tons of flue-dust stored awaiting the installation of a sintering-plant.

No changes have been made in the converting department. The converters operated steadily, with the exception of the five winter months, during which time they only worked 57 out of 152 days on account of lack of power. Additional converter-capacity is needed in this department.

The cost of smelting and converting was \$1.804 per ton of ore. This is 73c. less than in the previous year, but it is higher than was anticipated. The increase in wages, due to the rise in price of copper added 4.57c. per ton of ore. The use of about 20,000 tons of barren quartz in the re-grading and converting of matte (used on account of the scarcity of metal-bearing quartz) added 68c. per ton of ore. At the present time an endeavor to take care of this is being made with the opening of the Maple Bay properties. Lime flux added 15.2c. to the costs. Ore carrying excess lime would be advantageous in reducing this cost. The shipping of 21,428 tons of matte to the Grand Forks plant for conversion into blister-copper, on account of power shortage, added 2c. per ton of ore. Coke was a few cents higher on account of quality and handling in and out of storage, due to the irregularity of vessels' schedules caused by strikes of longshoremen. This added 1c. to the costs. Owing to the War, all supplies advanced 10% over normal prices. This meant an addition of 4c., making a total increase of 33.5c., the greater part of which amount will be eliminated in time.

During the past year there was considerable new work

that was found necessary to charge to operation, such items as fire protection of the 6-ft. water-pipe from the dam to the power-house, the railroad trestles, some agglomerator charges, new roof for main smelter-buildings, ore-bin extension, and charge-cars.

It is reasonable to expect a reduction in costs during the coming year. Ore costs would have been 6c. less had the profits made by the different departments, operating as independent concerns, been credited back. Another large item of expense which shows against costs for the past year is auxiliary power supplied for five months during the winter. The new steam-plant now under construction will take care of this heavy expense, and allow of operating to capacity throughout the coming winter. The sintering-plant, when installed, will take care of the flue-dust, and increase the recovery of copper.

Operations at the Grand Forks smelter were characterized chiefly by the handling of nearly 500,000 tons of material that was low in copper, about 1%, and highly silicious. Up to the present time this material has not

been calculated in the ore reserves, but on account of the high price of copper which has prevailed during the past year it became profitable to treat it. This partly accounts for the high costs of that period. However, for the first six months of the year costs were the lowest in the history of the plant, being \$1.233 for smelting and converting.

Owing to the high price of copper, the increase of wages added 1.7c. Coke was 1.3c. higher per ton of ore, due to the silicious nature of the ore. Anyox matte added 0.7 cent. The slow running of the furnaces, due to high-silica slags, offsets the increase of this year's costs over last year.

With eight furnaces in blast, there were from 195 to 200 men on the pay-roll.

There was no new construction during the year, but repairs have been maintained, and the plant is in first-class operating condition.

Credit is due W. B. Bishop, the superintendent, and the staff under him, for the good work done.

Flotation in the Supreme Court

The U. S. Supreme Court now has before it the appeal of Minerals Separation from the decision of the U. S. Circuit Court of Appeals in San Francisco in the litigation against J. M. Hyde, who represents the Butte & Superior Mining Company.

The complainant's brief states: "The distinctive feature of the invention patented is the employment of air bubbles in co-action with a minute and critical amount of oil in a mixture of ground ore and water so as to produce upon the surface of the water a froth containing substantially all of the metallic particles which can be easily flowed off or removed. This process was never used before. This result was never obtained before. The process is dependent upon the use of oil in a minute and critical amount and thorough aeration. If more oil is used, you do not operate the process, and you do not get the result.

"By using other and greater quantities of oil you operate a different process and you obtain wholly different results. That the critical amount of oil characterizing the process is a minute amount of oil (varying slightly with different ores and different oils) is merely a fortuitous circumstance. Nevertheless the process is dependent upon such definite minute amount of oil. Obviously, therefore, it cannot be said that the use of the minute amount of oil characterizing the process in suit as compared with prior disclosures suggesting the use of greater amounts of oil, is a mere improvement in degree suggested by the desire to economize in the use of oil, since every prior disclosure with which the process may be compared was wholly different in characteristics and essential mode of operation and principles involved and result obtained. The process of the patent in suit evokes new principles, employs a new mode of operation, and produces a new result, not heretofore evoked, employed or produced."

In argument for the defendant Hyde it was pointed out to the Court that "all flotation processes fall into one of three distinct classes: (1) The Elmore bulk oil or oil buoyancy flotation process; (2) the surface tension of film or skin flotation process; and (3) the gas-oil flotation process. The process * * * (involved) belongs to the third class, wherein the flotation is due to the buoyancy of bubbles of air or other gas." The defendant's argument states that "upon the subject of air the patent in suit contains only a single statement, wherein it is asserted that the froth or scum derives 'its power of flotation mainly from the inclusion of air bubbles introduced into the mass by the agitation. * * *'. Surely, no patentable discovery is involved in the observation of the obvious fact that a froth or foam floats by reason of the air in the bubbles of which it is formed and in any event, patentable novelty cannot be predicated upon a theory as to the cause of an old effect in the absence of some new means for producing that effect."

Relative to the amount of oil used the defendant's counsel argued that "the patent in suit contains no suggestion that the process can be practised with a 3.6% or 25% of oil relative to the ore. The patentees knew that such a statement would prevent them from obtaining a patent; therefore in order to make it appear that they had discovered something new they made the statement to the effect that the formation of a froth or scum grew out of and depended upon the use of a smaller amount of oil than used by Cattermole."

The Hyde counsel concluded their argument with the submission of a statement "that the decree of the Circuit Court of Appeals should be affirmed on each of the following grounds: That the patent in suit is anticipated and invalid; that all of the claims of the patent of which infringement is charged * * * are anticipated by each of the following processes, Everson, Froment, Schwarz, Glogner, and Kirby; and that those claims which do not specify the use of acid * * * are anticipated by the Haynes British patent."

Electrolytic Zinc-Dust

By Harry J. Morgan and Oliver C. Ralston

*The sudden increase in the price of zinc-dust after the beginning of the European war, owing to the cutting off of the German and Belgian supply, led to some experiments on the possibility of producing the dust on a commercial scale from solutions of zinc, and the substitution of the zinc made in this manner for the zinc-dust ordinarily used in the precipitation of gold and silver in the cyanide process.

As the Salt Lake City station of the U. S. Bureau of Mines, in co-operation with the Department of Metallurgical Research of the University of Utah, is carrying on investigations that have for their object the treatment of low-grade and complex zinc and lead ores or products, it was thought well to determine whether the zinc contained in such ores and products could not be utilized in the manner above indicated, and so supply the demand that had arisen for zinc-dust.

The United States, in 1913, imported 4,382,470 lb. of zinc-dust, valued at \$227,585. Most of this was from either Germany or Belgium. The domestic production, in comparison with the imports, was very small. In the years 1912 and 1913 the domestic production was 492 and 423 tons respectively, while the imports were 2400 and 2200 tons respectively. For a time the zinc-dust made in zinc smelters was a drug on the market and when first utilized in cyanidation could be bought for a lower price per pound than solid zinc. After the advantages of the use of zinc-dust for precipitation were realized, so much of it began to be used for this purpose that it brought a premium of about 3 cents per pound over what the value of spelter was at the beginning of the War. Since that time its price has averaged about 30c. per lb., without much fluctuation. Some American zinc smelters have undertaken to supply the demand, but their product has never been equal to the German zinc-dust.

Experiments were made by Morgan¹ in the application of a jet of air to atomize a column of molten zinc for making the dust. This work was conducted at the Bureau of Mines exhibit at the San Francisco exposition, but the zinc-dust was not satisfactory for cyanide precipitation. While it was fine enough to pass a 200-mesh screen, it was only 25% efficient in the precipitation of

silver from cyanide solutions and a microscopic examination showed that the small pellets of zinc were in the shape of congealed droplets, which present a minimum of surface for reaction with the silver cyanide solution. This idea has been further carried out at Anaconda and we are informed that 10 to 15 tons of atomized zinc is now being prepared per day, in preference to sponge zinc made by electrolytic deposition from sulphate solutions. This dust is being used for purification of zinc-sulphate solutions, for the reason that the more finely divided electrolytic sponge tended to clog up the Schriver filter-presses used at that plant.

To us, a better idea seems to be the making of a zinc sponge by electrolytic methods, the sponge to be of such a nature that it would crumble to dust when dried. The variety of electrolytic conditions available, with the different electrolytes that can be used, and the resulting great differences in the physical properties of the precipitated metal, gave promise of the possibility of a zinc-dust that would be highly efficient and rapid. As a result of experimental work, it is believed that this possibility has been realized. In addition to its use for precipitating gold and silver from cyanide solutions, zinc-dust can also be used in sherardizing, and for chemical purposes, such as reduction of organic compounds, etc. Sherardizing requires a considerable proportion of relatively coarse particles of zinc, similar to the atomized zinc above mentioned, but it is possible that the manufacture of dyes and other such chemicals in the United States can create a considerable demand for electrolytically prepared zinc-dust of high purity and efficiency. The following work was done with a view to preparing a product satisfactory for cyanide practice and does not consider the needs of the sherardizing industry, or of the chemical industries.

According to Sharwood,² zinc-dust for use in cyanide precipitation should be fine enough so that 90% of it will pass 200-mesh and it must be high in metallic zinc. A considerable amount of zinc oxide may be present without seriously affecting the efficiency of precipitation. The following method of testing the efficiency of precipitation by zinc-dust is given by Sharwood: After passing the dust through a 100-mesh screen to break up the lumps, 303 mg. is weighed out and added to 250 cc. of 1% silver-cyanide solution containing 0.15% free cyanide. The solution is stirred occasionally for two hours, after which it is withdrawn from the precipitated silver by filtration. The precipitated silver is dissolved in nitric acid and titrated with ammonium sulpho-

*A paper read at the recent meeting, at New York, of the American Electro-Chemical Society. By permission of the Director, U. S. Bureau of Mines. Communicated by D. A. Lyon, Metallurgist in Charge of Salt Lake Station of Bureau of Mines.

¹In this work Morgan was assisted by R. H. Bradford, Professor of Metallurgy, of the University of Utah, and under the direction of G. H. Clevenger, Professor of Metallurgy at Stanford University.

²*Jour. Chem. Met. Min. Soc., So. Africa*, VII, 332 (1912).

cyanate, using a ferrie salt as an indicator; or else the precipitated silver is scorified and cupelled to be weighed. Each milligram of silver precipitated represents 0.1% efficiency of precipitation. This test is merely an empirical one of general acceptance, admittedly near enough to allow of intelligent buying of zinc-dust. It is stated by Herz that the efficiency of zinc-dust should be over 40% and that dust with less than 30% efficiency generally gives poor results. Dust of over 50% efficiency is hard to obtain. The average grade of zinc-dust from Europe is 15% efficient, but in this work we have been able to get dust giving an efficiency of 74%.

The usual endeavor of the zinc hydro-electro metallurgist is to obtain solid reguline deposits of zinc rather than the sponge, as the sponge metal can rarely be melted into spelter. The literature on electrolytic zinc is full of instances where work was stopped on account of the 'tendency' of the zinc to be deposited in a spongy form. However, we found that, in duplicating this work and following the conditions as given, there is only a *tendency* and that the average result of such conditions is trees, warts, or loose crystalline zinc. We found as much difficulty in obtaining a true sponge as the beginner usually finds in getting smooth solid deposits. Conditions of high-current density and low-current density, high acidity and low acidity, or basicity, high temperature, etc., were tested and it was hard to get all the sponge that others had reported as being so easily obtained.

We have been informed that one metallurgical company produced several thousand pounds of zinc-dust in its electrolytic zinc plant at Welland, Ontario, by allowing the temperature of its solutions to go up above 70° C. and that it was used by one of the local firms with indifferent success. The electrolytic plant in question is operating a sulphate solution of zinc in which ore is suspended in the solution while the cathodes are protected by bags. Most of the sponge or the loose crystals prepared by us from sulphate solutions did not possess a high precipitating efficiency. Spongy zinc was formed when solutions of zinc sulphate containing dissolved zinc oxide were used, but as soon as the solutions became acid, owing to the formation of sulphuric acid at the anode, the zinc lost most of its spongy characteristics. An excess of zinc oxide suspended in an open cell is not desirable, as it mixes with much of the loose zinc sponge formed. Removal of the solution to an outside vat, for treatment with zinc oxide, is not desirable on account of the slow, and low solubility of the zinc oxide in the zinc sulphate solutions.

The method of adding impurities to the solution was tried in order to get spongy zinc. Copper and arsenic were found to be most efficient for this purpose, but copper is not a desirable constituent in zinc dust on account of its presence in the precipitate of the precious metals. Arsenic is also undesirable in the precipitate, if the lat-

ter is to be treated with sulphuric acid before melting into bullion, owing to the formation of poisonous arsine. All the copper was found to be deposited quickly from solution with the sponge zinc, but after the deposition of the copper, the zinc deposits began to be more solid and crystalline. A continual drip of copper sulphate into the electrolytic vat is hence necessary. The addition of iron as an impurity did not result in producing successful sponge zinc. Furthermore, the oxidation and reduction of iron salts at the electrodes lowers the current efficiency.

The favorable results obtained in solutions made slightly basic encouraged the use of basic solutions of zinc, such as sodium zincate. The zincates allowed a wider latitude in the precipitation of zinc sponge than any other solutions tested. Lead anodes tend to dissolve, and zinc anodes dissolve almost quantitatively. Iron anodes are practically unaffected, especially those made of the better grades of iron. After doing this work it was discovered that practically the same idea had been patented by Sherard Cowper-Coles in British patent No. 13,977 of 1907. The electrical conditions best for this work are not mentioned by him, but we find that a wide range of voltages is allowable, and most of our work has been done at a current density of about 300 amp. per sq. ft. (3225 amp. per sq. m.). Cowper-Coles mentions the possibility of using galvanized "hard zinc" for anodes when making sponge zinc, as the iron is not dissolved, while the zinc is, thus lowering the operating voltage and replenishing the solution. He also recommends the use of a rotating vertical disc for a cathode, a form of cathode which we had adopted after some considerable test work. The disc can be made of iron and the upper half projects out of the electrolyte. The sponge is scraped off the disc into water as the disc slowly revolves. Rapid rotation of this disc is not allowable, as the better agitation of the electrolyte causes the formation of adherent zinc, which defeats our purpose. To have a barely perceptible motion of the disc is sufficient. We had anticipated trouble in the drying of the dust, but met with none, as we found it could be heated to 250° C. on the hot plate in the open air without ignition. The washing of the sponge free from the adhering solution of sodium zincate must be performed with weaker caustic, as the zincate hydrolyzes in water solution to zinc hydrate and sodium hydrate. A water-wash can follow a caustic soda wash. The dust prepared in this manner was highly efficient (over 70%).

LARGE-TIN SMELTERS in the world are in the Straits Settlements. One, that of the Straits Trading Co., has a capacity of 35,000 tons per year; the other, of the Eastern Smelting Co., treats 17,000 tons. The Dutch Government smelters produce 15,000 tons. Capacity of English plants is 28,000 tons. Germany can reduce 11,200 tons, and the A. S. & R. Co. at Baltimore in its new plant is smelting 3500 tons. Australian smelters make 35,000 tons per annum. These figures refer to metallic tin.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

CONDITIONS IN THE ZINC REGION DURING OCTOBER.

Returns from the Wisconsin zinc region for October, from the 1st to the 25th, inclusive, scarcely reflect the healthy conditions that prevailed during the period. At the beginning of the month the markets were not entirely satisfactory from the miner's point of view, standard and premium grades of zinc ore holding on a base of \$60 per ton, with the range down to \$50 on second and medium-grade ore. Shrewd buying interests, knowing that prompt metal was becoming scarce and that better prices might be anticipated, skillfully secured a large proportion of the output by entering into contract arrangements for ore on long terms. The Eagle-Picher Lead Co. of Joplin, Missouri, bought heavily of high-grade material before advances in the price of zinc ore had really set in. These advances materialized as the month went on, standard and premium grades commanding a base price of \$70, with second and medium grade at \$65 per ton base. At these figures buying became active, and high-grade ore was cleaned-up at all points, while a freer movement of medium-grade ore set in that affected the low grades, much of which had lain in bins for many months. The reserve in the field at the beginning of the month, estimated at 5000 tons, has been reduced to 1500 tons, and this would be eliminated on short notice.

An acute shortage of labor developed in the southern districts of the field, which operators found it difficult to meet. The final closing-down of four consistent producers, throwing 250 men out of employment failed to relieve the situation, as ready employment was offered each man at near-by producers. Production failed to come up to expectations, the recovery of crude concentrate for the month aggregating 18,000,000 lb. It was considered that better offerings would stimulate producers to exert themselves to meet the better demand and better offerings, but in this view many were disappointed. It was held in many quarters that producers keenly scented better market conditions through the winter months, and preparations were made for an increased production when the time was ripe. This led to greatly increased labors in underground development, additional installation of buildings and machinery while the weather was good, and the rushing of work to get new mines with new surface outfits into working order. All this was accomplished during the month, and will be appreciated in the better showing in output throughout the remainder of this year. Facilities for handling crude concentrate at zinc-ore refineries were somewhat enhanced, and in addition plans were laid for the early construction of a new plant at Whitson Junction, a connecting point on the Northwestern railway well removed from settlement, as sentiment at several points in the field had developed against refineries because of the nuisance from fume. In the Galena district this reached a critical point, the city authorities serving notice on one of the large companies to abate the nuisance or close-up the plant.

Lead ore was in good demand all the month at greatly improved prices, but producers showed little interest in the market, and shipments were light. Offerings toward the end of the month were in excess of \$85 per ton, but the bulk of the ore was held closely and the reserve in the field was well on toward 1000 tons.

Shippers of pyrite enjoyed a better demand, and more tonnage was disposed of, but a fairly good reserve was still held

at the close of the month. The acid department of the New Jersey Zinc Co.'s plant at Mineral Point showed increased activity, and one 25-ton tank-car of commercial sulphuric acid was sent out daily.

Producers of carbonate of zinc ore experienced an exceedingly poor month. Prices for this ore are kindred with quotations usually published for calamine ores. At the close of October, in sympathy with the higher prices for blende, price had advanced to \$45 per ton, 40% base; but Wisconsin producers went begging for a market until well along toward the close of the month, when outside buying interests stepped in and cleaned-up several hundred tons, with the immediate prospect of taking all such ore as local producers had to offer. Such shipments as were made came from the mines of the New Jersey Zinc Co. in the northern districts of the field.

Several new producers commenced at eight different points in the field; five producers shut-down indefinitely. There were in course of construction new plants at four different points, and mine development was noted in every district of the field. Drilling operations were extensive, especially for the larger operators.

Deliveries of ore of all grades for October were as follows: 45,254,000 lb. of zinc, 766,000 lb. of lead, and 6,408,000 lb. of pyrite.

The Mineral Point Zinc Co. delivered 5,232,000 lb. of high-grade refinery product to smelter at DePue, Illinois. The total shipments of high-grade ore out of the field from refinery plants to smelter direct totaled 12,790,000 lb. The heaviest outside buyer for the month was the Grasselli Chemical Co. of Cleveland, Ohio, with 3859 tons. The Eagle-Picher Lead Co. came next with 1728 tons.

SUTTER CREEK, CALIFORNIA

LABOR SITUATION.—CENTRAL EUREKA TO SINK.

Within the past week, a large number of Spaniards have come to Jackson, Sutter Creek, and Amador City, most of whom are finding employment in the mines at Jackson and the South Eureka property here. The Fremont company is also adding some of these men to its pay-roll, being shorthanded since the strike. Most of the companies have their mills in full operation, but local miners resent the fact that the Fremont, South Eureka, Kennedy, and Argonaut companies pay less than the general scale of wages for certain work, and are also discriminating to some extent against the leaders in the recent strike. This doubtless accounts for their requiring the services of outside men.

Preparations are almost completed for sinking the Central Eureka shaft far enough below the 3200-ft. station to allow for two new levels. At present this is the lowest point worked in the mine, although the shaft sump is nearly 75 ft. below that station. The engine heretofore used at the 2800-ft. winze has been installed at 3100 ft. in the shaft, and at this point will be dumped all the rock and waste from shaft-sinking; this material to be used for filling stopes, instead of its delaying mining operations by being hauled through the shaft. A bulkhead will be put in the shaft for the protection of men working below, and rapid progress can be made when sinking is started within the next few days. It is expected that at least half of the 40-stamp mill can be kept working steadily while sinking is in progress, as fair grade ore is being mined on the 2800, 3000, and 3100-ft. levels.

THE MINING SUMMARY

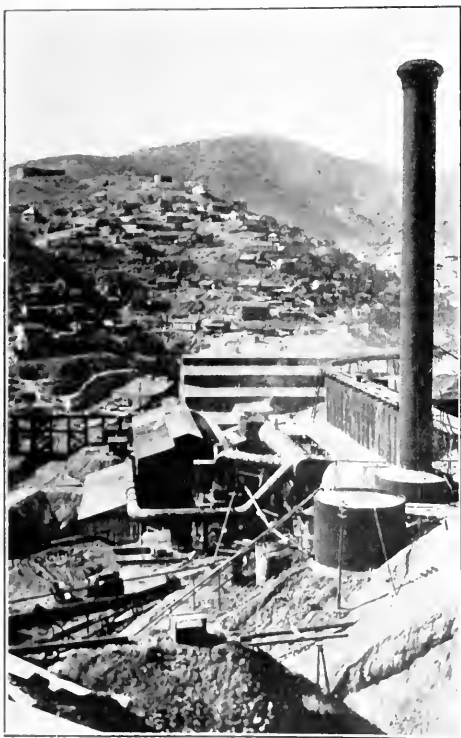
The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

In Bulletin 631 of the U. S. Geological Survey, H. M. Eakin discusses the Yukon-Koyukuk region, in 88 pages. The area embraces 12,000 sq. miles in central Alaska, between the Yukon and Koyukuk rivers. The predominant topography is rolling uplands. Winters are long and cold. Game is generally abundant. Steamers ply on the rivers during the open season. Alluvial gold is widely distributed in the region, but save those of the Indian river the deposits have so far shown little economic importance. There are no gold lode mines.

ARIZONA

BISBEE. Three companies—The Louisiana-Arizona, Bisbee



DETROIT COPPER CO.'S MILL AND SMELTER, MORENCI, ARIZONA.

Copper, and another are to start exploration of the copper-bearing area outside of the Warren district. Sufficient capital is said to be interested in these schemes.

GRONK. A crosscut on No. 11 level of the Arizona Commercial has passed through 50 ft. of ore, 15 ft. of which is high grade, the remainder concentrating ore. On No. 10 level the hanging wall side of the vein is a sulphide assay 25% copper. Six feet of siliceous concentrating ore contains 3.5%.

PHOENIX. At the third annual meet, held on the 14th, the Old Dominion team won the mine-rescue contest, with Calumet & Arizona second, and Detroit third. C. & A. won the first-aid event, followed by Old Dominion and Ray Consolidated, who tied.

YUCCA. In the Bulletin of the Chamber of Mines and Oil of Los Angeles, F. L. Wilson briefly describes the tungsten deposit near this place, which is 32 miles north-east of Topock in Mohave county, and 16 miles south-east of Needles. Pegmatite dikes cut a belt of schist, limestone, and quartz. Wolframite is the principal tungsten mineral. Copper occurs nearby. Molybdenite is found in the Hualapai range, east of Yucca, in quartz veins cutting granite and schist.

Sixty-five tons of ore containing 39.26% copper was the last shipment from the Grand Gulch mine in Mohave county to Utah smelters. Salt Lake City people control the property, which has a peculiar orebody. Dividends this year total 4c. per share, equal to \$10,000. This mine, which has an ore deposit of circular shape, was described in the Press of July 11, 1914.

CALIFORNIA

DOWNIEVILLE. The Morning Star and London Tunnel mines are to be re-opened by Los Angeles people, and supplies are now being sent in.

(Special Correspondence.)—The Allison Ranch company is about to construct its mill and cyanide plant. Excavation is complete. The head-frame is almost finished. Excellent headway is being made in unwatering the mine. The Golden Center company will start shortly excavating for its new cyanide plant. C. A. Brockington is in charge of both of these properties, and F. A. Vestal is consulting metallurgist.

The Delhi mine has been unwatered and the mill is being overhauled for early resumption of milling. R. E. Tremoureux is in charge.

The Indiana Dredging Co. has taken a lease on several miles of creek at Greenhorn valley, a few miles from this town. They are sinking shafts, and contemplate constructing a large dredge. D. H. Ferry is in charge.

A new 5-stamp mill is being erected at the Mariposa mine, a short distance from Alleghany. This property is one of the promising quartz mines in the district.

The North Star company continues improving its plant. Grass Valley, November 13.

GRASS VALLEY. The Union Hill, Gold Point, and South Idaho mines are to be consolidated by the company that recently purchased the first-named. The main shaft is being sunk from 800 to 1200 feet.

LA POINTE. The concrete retaining dam on Slate creek, constructed to permit of hydraulicking at St. Louis and Howland Flat in Sierra county, is practically complete.

MEADOW LAKE DISTRICT. This region is in the eastern part of Nevada county, and indications point to a busy season next year. The Old Man Mountain and other claims of H. D. Ramsey have been sold for \$101,000. A number of small properties have been actively worked with favorable results.

RIDGING. To drill for oil near Buckeye, the Pacific Oil Co. has been organized with W. Wolfe of San Francisco as president.

(Special Correspondence.)—The Harvard mine, near Jamestown, which has regularly employed 100 or more men for a number of years past, has suspended operations. Whether

there is likely to be an early resumption of activities cannot be stated with any degree of certainty, nor has anyone with authority announced the cause of the shut-down.

The California Gold Mining & Development Co. has secured an option on the Chaparral mine, south-east of Tuolumne, from F. A. Wenzel, of Sonora. It is understood that the company has also acquired several adjoining properties. A Sullivan air-compressor and machine-drill will be purchased, and it is expected that the drift will be driven at the rate of 10 ft. per 24 hours.

Electric power and water have been brought to the Red Jacket mine, at Big Oak flat, and the small mill on the property was started recently. So far the ore crushed has given highly satisfactory returns.

The working crew at the Springfield Tunnel & Development Co.'s deep-gravel property was recently reduced to three or four men. Active work underground will, it is said, be resumed before long. Meanwhile prospecting with a Keystone drill will be done to ascertain the exact course, depth, and richness of the several gravel-channels.

The Columbia Basin gravel mine, whose shaft is 200 ft. deep, is being unwatered preparatory to the resumption of operations.

The flotation plant being installed at the Dutch mine will be given its initial trial within a few days. Extensive development work has been done since W. J. Loring assumed management, and some valuable discoveries have been made, among which may be mentioned the opening of a fine orebody below the 1800-ft. or bottom level, by means of a winze, now 130 ft. deep.

Harris Bros. & Moore have started sinking a shaft on the Ben Soulsby ranch, near Soulsbyville. It is expected that at a depth of 40 ft. the vein, which gave high assays in other shallow workings, will be encountered. A gasoline engine and centrifugal pump have been installed.

A contract has been let for sinking the shaft at the Garfield 100 ft. and driving a drift 200 ft. The property recently changed hands.

The shaft at the Columbus mine, north of Tuolumne, has attained a depth exceeding 300 ft. Good ore shows in the shaft almost from top to bottom, and the management is elated over the results of development thus far. Thirteen men are on the pay-roll.

Sonora, November 14.

(Special Correspondence.)—W. J. Loring has taken an option on the Harvard mines on the Mother Lode, a mile west of this town, the papers having been signed on the 16th. The mine has been idle for a short time pending a preliminary investigation.

Jamestown, November 17.

(Special Correspondence.)—One after another of the old mining properties of Tuolumne county are being re-opened, and the prospects for greater activity in mining than for several years is promising.

At the Red Jacket mine in the Big Oak Flat district the mill is running three shifts on good ore. Electric power is being used to run the mill and compressor. This mine but recently began operations and the outlook is bright.

While plowing on his farm near Columbia, William Rhem unearthed a \$100 nugget. It was found near Springfield flat, which produced many millions in the early days.

The flotation process at the Dutch-App group of mines will soon be in operation. It is being watched with much interest by many mining men of Tuolumne county, as this is an innovation in gold-ore treatment here.

The old Bonanza mine, in the centre of Sonora, is soon to be re-opened. This mine has produced over \$2,000,000 in pocket gold, and is expected to soon be on the producing list again. It has been bonded to J. B. Curtin and George Weston of Sonora.

Sonora, November 12.

COLORADO

LEADVILLE. Pumping commenced at the Harvard shaft of the U. S. S. R. & E. Co. last week, and unwatering should be finished in a short time.

A 300-hp. electric hoist, the largest in the State, has arrived at the Mikado shaft. The pumping equipment has not been delivered so far.

TELLURIDE. During the year ended June 30, 1916, the Tomboy Gold Mines Co. made a profit of \$379,000. Two dividends absorbed \$140,000. After paying English taxes and depreciation the balance was \$95,000. The mill treated 150,488 tons of ore, yielding \$1,074,080. The average cost was \$4.92 per ton. Reserves in the Argentine mine are 175,000 tons; in the Montana 400,000 tons, a total of 575,000 tons.

IDAHO

ADAIR. According to H. M. Lancaster, recently superintendent, the Richmond mine contains over \$1,000,000 of ore ready for extraction in the two upper levels. A recent car-load averaged 15.5% copper.

HAILEY. The new 150-ton mill of the North Star-Triumph claims is nearly complete. The Federal Mining & Smelting Co. controls the property.

KELLOGG. During the quarter ended September 30, 1916, the Caledonia Mining Co. made a profit of \$296,390. Development is being carried on in the Keating tunnel-level in an effort to recover the faulted orebody, but so far without success. The work is being continued, however, and the area in which it is thought that the lost shoot will be found is to be thoroughly explored. The metal output was 2,652,600 lb. lead, 350,422 oz. silver, and 220,681 lb. copper. Cash, ore on hand, and in transit, etc., is \$375,366 net.

LOON CREEK DISTRICT. The Lost Packer copper mine in Custer county has been closed for the winter, the usual procedure on account of transportation difficulties. The 50-ton mill, using flotation, recovered 90% during the season. P. Sheahan is manager.

MULLAN. According to George Huston, geologist of this place, three questions are interesting mining people in the Coeur d'Alene: (1) the entrance of the Anaconda Copper Co. into zinc-ore buying, (2) how lower development in the Interstate-Calahann mine will result, and (3) the status of the National copper mine, near Mullan.

PINE CREEK DISTRICT. The Coeur d'Alene Antimony Mining Co. has increased its capital from 500,000 to 1,500,000 shares, 10c. par value. Investigations are being made into the treatment of ore, and the production of metal or oxide. The mill can treat 100 tons of ore daily. A large tonnage of ore has been developed.

MISSOURI

JOPLIN. Prices for zinc ore were \$10 per ton higher last week, the range for 60% product being from \$75 to \$90. The output of the Missouri-Kansas-Oklahoma region was 7664 tons of blende, 832 tons of calamine, and 612 tons of lead, averaging \$2.50, \$47.50, and \$87 per ton, respectively. The total value was \$718,068.

The deputy State mine inspector, J. H. Myers, considers that sanitary and protective measures are being increasingly observed by operators in the Joplin district.

MONTANA

BUTTE. On the 2500-ft. of the Davis-Daly mine the '2501' vein has been opened 500 ft., with 15 ft. of ore still in the face. For 450 ft. the average over a width of 12 ft. was 57% copper, also 1.6 oz. silver with each unit of copper.

In its north-west adit the North Butte company has cut 18 in. of sulphide ore assaying 3.25% copper and over 2 oz. silver per ton. This development is in the eastern part of Butte.

The Butte-Detroit company is to treat zinc ore for the Davis-

Dal. company, while the Anaconda company may treat the ore concentrate at Great Falls.

According to H. N. Knowlton, of the U. S. Forest Service, 20% of the total cost of mining is for timber used.

The report of the Barnes-King Development Co., which operates in Ferguson county, shows that during the third quarter of 1916 the profit was \$6457. The revenue from gold-bullion was \$107,887. Total income was \$203,037, which included balance from June 30, power-plant earnings, royalty, and notes payable. The Shannon mine made a profit of \$23,606, the North Moccasin and Piccan-Gloster mines losses of \$7089 and \$8684, respectively. Considerable expenditure was made in improvements and payments for properties. In October 3360 tons of ore yielded \$77,550.

CRINOID. In this district of Missoula county, F. G. Bond has discovered rich bismuth ore. The vein is in quartzite and granite.

NEVADA

GOLDFIELD. The Jumbo Extension company is to prospect with a core-drill through the shale and into the alkali.

Owing to the copper-gold ore in the Florence being too low grade, treatment has been suspended and the mine closed. In treating 200 tons daily by flotation the process was quite satisfactory.

A raise above the 880-ft. level of the Jumbo Junior is in good ore near the Kewanas boundary.

GOODSPRING. Estimates of reserves in the Bullion mine give at least 12,000 tons of 12% lead ore for the 125-ton mill. There is also a good deal of shipping ore opened.

LAS VEGAS. Platinum has been detected in the Eldorado Enterprise Gold Mining Co.'s property in Eldorado canyon. Rich gold-silver ore has been opened in the Carnation claim. A stamp-mill and cyanide-plant are proposed by lessees of the Lombard claim.

(Special Correspondence.)—At a depth of 20 ft. rich ore has been intersected on the Lombard claim by Charles Herman, M. Fisher, and James German. The ore assays \$1000 per ton in gold and silver, and was discovered near the Carnation claim, the scene of a good strike two weeks ago.

The shaft of the Cliff Era is down 155 ft., and is being sunk 200 ft. in expectation of intersecting a large vein that has been traced on the surface for 4000 feet.

Ore of good grade is showing in the shallow workings of the Eldorado-Empire, and arrangements have been made to sink the shaft to considerable depth. A compressor, drills, and other machinery have been purchased.

Representatives of San Francisco capitalists are examining several mines in the Eldorado Canyon field, and a number of important deals are stated to be in course of negotiation. San Francisco people are in control of the Enterprise group, and are opening good ore.

Searchlight, November 12.

NEW MEXICO

(Special Correspondence.)—The Socorro M. & M. Co. shipped 23 bars of bullion from the claim up for the last half of October, a total of 41 bars, or a little over two tons for the month, from the treatment of 5000 tons of ore. The product of the Mogollon Mines Co. for second half of the month was 12 bars, making 25 bars for October, worth 4100 tons. In addition, several tons of concentrate was shipped to smelter at El Paso.

The Oals Company's 125 ft. cut of ore to bottom mill from exploratory work in the Clinton mine gave \$14 per ton. The ore came from the Queen vein.

At the Gold Dust prospect, on which work was lately resumed, the main adit is under consideration of retreating, and raises and drifts are being extended.

Earl C. Cleveland, who, as we have been reporting, has data relative to hydrocarbon gas or possibilities in this region, has just returned from the oil fields of the Gila river,

where he and others have run surveys and taken water readings over a period of two years. So far the average flow found, under available head, if sufficiently developed, will take care of both present and prospective power requirements of the district. When some such project is consummated Mogollon will be able to treat profitably an almost unlimited quantity of low-grade ore that otherwise is unavailable under present high-power costs.

Mogollon, November 7.

TEXAS

(Special Correspondence.)—The recent resumption of copper mining in the lower part of the 'Panhandle' region of Texas recalls one of the most magnificently equipped and spectacular expeditions that was ever sent out to extract metal from the earth, having for its object mining of copper in the same area where the work has been again started under more modern auspices. In 1881, the Grand Belt Copper Co. was organized by G. B. McClellan, a general during the Civil War, who found copper there years before. The New York capital behind the company bought 250,000 acres of land, supposed to embrace the deposit. Gainesville was then the nearest railroad point, a 75-mile haul. The miners were mostly cowboys. Mining operations were more like digging prairie-dog holes than anything else. Large 'modules' of copper were gathered at times, two carloads being shipped East. There was much buying of shares on the strength of this ore. No defined vein could be found during six years' work. A 10-ton smelter and 20-ton stamp-mill were erected. It was not then possible to extract the copper from the clay. Finally the company collapsed. Thousands of ore-sacks and machinery were abandoned to be taken by farmers and others. The one improvement, in Knox county, was a good flowing artesian well, 4000 ft. deep, and said to be flowing yet.

Austin, November 4.

(Special Correspondence.)—The Southwestern Mining Co. is developing a lead-zinc, silver mine near here. It has been making regular shipments of ore to the smelter for some time past. In the 300-ft. level a large body of ore that is high in lead and zinc with about 50 oz. of silver per ton was encountered.

Sierra Blanca, November 11.

(Special Correspondence.)—The West Texas Sulphur Co. is preparing to exploit two large sulphur deposits that it owns near here. It will install retorts for the treatment of the sulphur-bearing material, and a plant for refining the product.

Toyah, November 11.

UTAH

ALTA. Daily shipments from this district are from 100 to 125 tons of first-class ore, mostly from the South Hecla and Michigan-Utah. Good progress is being made with the new railway from Wasatch to Alta.

At the Wasatch Mines property the open-cut, which goes below the proposed new tunnel, is 1000 ft. long. On account of loose gravel the tunnel has not been started yet.

BINGHAM. The Montana-Bingham tunnel is in 4300 ft., the daily advance being 15 ft. with two shifts. The face is in quartzite.

The Utah Consolidated will pay \$1.50 per share on December 20, a total of \$150,000, and \$1,125,000 for the current year.

DUNN. This old district, 23 miles west of Oasis on the Salt Lake Route, is busier than for years. The ore is mainly copper-bearing.

PRIOR. Twenty miles south-west of this place the Copper Globe Mining & Smelting Co. is opening a large deposit of ore that is to be mined by steam-shovel. The ore, a carbonate, occurs in sandstone formation. A 25-ton smelter is to be erected.

SALT LAKE CITY. The Edison Mica Mines Co. is to resume

work at its gold mine a little south of Little Cottonwood canyon.

WASHINGTON

CHEWELAH. On December 15 the United Copper Co. pays 1c. per share, equal to \$10,000. This is the first distribution for four years. The mine is in good condition. The mill is recovering 90% of the copper and 92% of the silver.

CLAYTON. The Silver Bell Mining Co., capitalized at 1,500,000 shares of \$1 each, of which 500,000 shares are to be held in the treasury, has been organized to take over and continue development of the old Spokane Belle mine, four miles from here. This is one of the oldest mineral locations in the northwest, and contains good silver ore. E. H. Belden, pioneer attorney, is president.

CANADA

BRITISH COLUMBIA

THREE FORKS. The Rambler-Cariboo Mining Co., with mines and a mill at Three Forks, has sold 1000 tons of concentrate stored at the property to the United States Zinc Co. for \$23 per ton. The product will average 34% zinc and 28 oz. silver per ton. Reports from the smelter have also been received stating that \$13,000 is due in settlement for lead-silver ore. Production of 1000 tons of zinc concentrate monthly is possible, in addition to the regular lead-silver output, according to A. F. McClaine, Jr., son of the president of the company, and it is probable that the entire zinc output will be taken by the United States Zinc Co., with the exception of a small amount for experimental purposes at the Anaconda Copper company's new electrolytic reduction works at Great Falls, Montana. Shipments of the 1000 tons of concentrate sold to the United States company will be made to its plant at Blende, Colorado, as soon as cars can be obtained.

ONTARIO

COBALT. During October the Nipissing mills treated ore yielding \$233,646. The refinery shipped 565,404 oz., including custom bullion. Underground developments were favorable. The most important were on four raises on vein 490 on No. 5 level. Here the average of each was 6 in. of ore assaying 1000 oz. per ton; some showed 10 in. of 1800-oz. ore. At shaft 81, 425-ft. level, a shoot was found in the Cobalt Lake fault-vein, 20 ft. long, 12 in. wide, assaying 1200 oz. per ton.

KOREA

The Seoul Mining Co., operating the Suan concession in Whanghai province, Chosen, reports a total recovery of \$138,250 for October.

MEXICO

The date when mines in the Republic shall become subject to forfeiture because of non-operation has been extended to January 14, 1917, in cases where conditions have prevented resumption of work. November 15 was the date set for the forfeiture of mines which had been idle for two months from September 14, the date on which the forfeiture decree went into effect. Luis Cabrera, chairman of the Mexican-American Commission, which is conferring at Atlantic City in an endeavor to settle outstanding differences between the two countries, notified the American commissioners on November 13 that General Carranza had extended the time-limit for the resumption of work in the Mexican mines for 60 days from November 14. He added that Mexico did not desire to confiscate property by trying to force owners to work it under impossible conditions, and intimated that the time-limit of the decree might be extended again, either for the entire country or for certain districts, should conditions warrant at the expiration of 60 days.

The San Francisco section of the A. I. M. E. will meet at the Engineers Club on December 12 to hear a paper on 'The Origin of Petroleum in California,' by John C. Merriam.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

FRANK MOSS is here from Western Australia.

CLARENCE J. PETERSON, recently at Tonopah, is in San Francisco.

ARTHUR WINSLOW was here, from Boston, during the past week.

E. B. KIMBALL has returned to San Francisco from the Wyoming oil-field.

F. G. COTTRELL lectured at Salt Lake City on November 20. He is now at Washington, D. C.

ARTHUR W. STEVENS is at Quartz, Tuolumne county, on the staff of the Dutch Sweeney mines.

F. M. FIELD of Virginia City, Montana, engineer for the Elling estate, has returned to Los Angeles.

C. T. HUTCHINSON, business manager for the M. & S. P., is at Denver, on his return from New York.

C. B. CLYNE is building a 100-ton copper flotation plant for the Werniger Mines Co. at Woody, California.

GEORGE F. ZOFFMAN, superintendent of the Cinco Minas mines, in Jalisco, Mexico, is here on a holiday.

ARTHUR JARMAN has resigned as assistant superintendent of the Grand Junction mine at Waihi, New Zealand.

F. R. WEEKES has been in British Columbia and California, and will return to New York the latter part of the month.

C. T. GRISWOLD, of the Associated Geological Engineers, is in Wyoming, and ERNEST MARQUAROT, of the same organization, is in Kansas.

C. E. MILLS, general manager of the Inspiration Consolidated, has been appointed managing director of the Cananea Consolidated in Sonora, Mexico.

P. N. NISSEN, the designer of the Nissen stamp, has added to his reputation by inventing a military hut, which has been adopted by the British army in France.

W. EARL GREENOUGH, for five years manager for the Marsh Mining Co., in the Coeur d'Alene region of Idaho, has resigned to engage in consulting practice. He has opened an office in the Old National Bank building at Spokane and will be assisted by S. B. DAVIS, formerly at Wallace, Idaho.

ARTHUR M. GREENFELL, formerly chairman of the Camp Bird, the Messina, and other mining companies, who became involved in an unpleasant and serious financial collapse just before the War, has distinguished himself in battle, having been promoted to Major and awarded the D.S.O. for conspicuous gallantry.

According to a Mexican refugee from Parral, Chihuahua, Mexico, who arrived at El Paso, Texas, on November 14, the Americans and other foreigners left Parral two days before General Luis Herrera evacuated the town. The Americans stated that before they left a party of foreigners in charge of LESLIE WEBB, an employee of the Alvarado Mining & Milling Co., was going to the town of Culiacan, near the west coast of Mexico, but the refugee thinks they are hiding in the mountains west of Parral, and gave out the story that they were going to the Pacific Coast to deceive the Villa bandits. The refugee said he knew that T. G. HAWKINS, JR., HOWARD GRAY, A. W. MORRIS, and BERNARD McDONALD had left Parral safely. Other Americans known to have been in Parral and believed by him to have left at the same time were: Dr. A. H. WHITLEY and son, Dr. T. J. FLANNAGAN, W. E. COWELL, W. C. PALMER, and JACOB MEYER.

WILLIAM RULE, managing director of the La Blanca y Anexas Co., died at Mexico City on November 5 at the early age of 48. His death is deeply mourned at Pachuca, where he had managed the mining interests of his distinguished father, Capt. Frank Rule.

THE METAL MARKET

METAL PRICES

San Francisco, November 24

Antimony, cents per pound	12.50
Electrolytic copper, cents per pound	31
Pig lead, cents per pound	7.25-8.50
Platinum, soft and hard metal, per ounce	195-111
Quicksilver, per flask of 75 lb.	\$80
Spelter, cents per pound	13
Tin, cents per pound	15
Zinc-dust, cents per pound	20

Platinum in London is \$18 per ounce, less than half the American price.

ORE PRICES

San Francisco, November 24

Antimony, 50% metal, per unit	\$1.25
Chrome, 40% and over, f.o.b. cars California, per ton	15.00
Magnetite, crude, per ton	8.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO ₃ per unit	15.00

New York, November 15

Antimony. Little ore is to be obtained, as the price is considered too low to induce shipments from abroad. The quotation is unchanged at \$1.50 per unit.

Molybdenite. Offerings continue small, consequently trading has been light. The business done has been on the basis of \$1.75 per lb. for 99% MoS₂.

Tungsten. Business has been active, several hundred tons having changed hands for domestic consumption, leaving stocks low both at Pittsburgh and New York. Transactions are again recorded at \$17 per unit, at which figure contracts to cover the early part of 1917 have been made. Europe wants ore, but seems unwilling to pay the price. It is declared that Great Britain has contracted for the output of several South American mines over a long period. Japan, it is stated, is not permitting a free exportation of tungsten.

EASTERN METAL MARKET

(By wire from New York)

November 24. Copper is quieter though strong, first quarter being \$2.50; lead is stronger, independents advancing; the strong demand for spelter is unsatisfied.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Nov. 15	27.50
" 16	27.50
" 17	27.50
" 18	27.50
" 19 Sunday	27.50
" 20	27.50
" 21	27.50
Nov. 22	27.50
Nov. 23	27.50
Nov. 24	27.50

Month's averages

Date	1914	1915	1916
Jan.	14.1	12.60	14.20
Feb.	14.16	14.78	16.67
Mar.	14.11	14.80	16.67
Apr.	14.19	16.61	18.67
May	14.92	18.41	19.67
June	14.60	19.11	20.67

On December 15 Copper is quoted at \$2.50 per lb. pure. The London market is quoted at \$2.50 per lb. pure. The New York market is quoted at \$2.50 per lb. pure. The San Francisco market is quoted at \$2.50 per lb. pure.

SILVER

Below are given the prices of silver in New York and London, in cents per ounce, of fine silver.

Date	Average week ending
Nov. 15	61.00
" 16	61.00
" 17	61.00
" 18	61.00
" 19 Sunday	61.00
" 20	61.00
" 21	61.00
Nov. 22	61.00
Nov. 23	61.00
Nov. 24	61.00

Month's averages

Date	1914	1915	1916
Jan.	61.00	61.00	61.00
Feb.	61.00	61.00	61.00
Mar.	61.00	61.00	61.00
Apr.	61.00	61.00	61.00
May	61.00	61.00	61.00
June	61.00	61.00	61.00

The position in silver appears to be strong, with an upward tendency. Supplies have been received at London with much regularity. India has come into the market, also China, though exchanges there remain steady, probably due to the reduction in metal stock at Shanghai, namely, 31,500,000 oz. since the beginning of the year.

Silver valued at \$630,000 was shipped from San Francisco to the Orient on November 11.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Nov. 15	7.00
" 16	7.00
" 17	7.00
" 18	7.00
" 19 Sunday	7.00
" 20	7.00
" 21	7.00

Monthly averages

Date	1914	1915	1916
Jan.	4.11	3.75	5.95
Feb.	4.02	3.83	6.23
Mar.	3.91	4.04	6.26
Apr.	3.86	4.21	6.70
May	3.90	4.24	7.38
June	3.90	5.75	6.88

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Nov. 15	11.50
" 16	11.75
" 17	12.00
" 18	12.00
" 19 Sunday	12.25
" 20	12.25
" 21	12.25

Monthly averages

Date	1914	1915	1916
Jan.	5.11	6.50	18.21
Feb.	5.22	9.05	19.99
Mar.	5.12	8.40	18.10
Apr.	4.98	9.78	18.62
May	4.91	17.03	16.05
June	4.81	22.20	12.85

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds

Date	Average week ending
Nov. 15	80.00
" 16	80.00
" 17	80.00
" 18	80.00
" 19 Sunday	80.00
" 20	80.00
" 21	80.00

Monthly averages

Date	1914	1915	1916
Jan.	29.25	51.90	222.00
Feb.	29.00	60.00	295.00
Mar.	29.00	78.00	219.00
Apr.	29.00	75.00	90.00
May	29.00	111.60	111.60
June	29.00	71.70	71.70

TIN

Price in New York, in cents per pound.

Date	Average week ending
Nov. 15	80.00
" 16	80.00
" 17	80.00
" 18	80.00
" 19 Sunday	80.00
" 20	80.00
" 21	80.00

Monthly averages

Date	1914	1915	1916
Jan.	29.25	51.90	11.75
Feb.	29.00	60.00	12.60
Mar.	29.00	78.00	30.50
Apr.	29.00	75.00	31.19
May	29.00	111.60	19.10
June	29.00	71.70	12.07

Tin is quoted at \$1.10 per lb.

The market for tin is quiet in New York, with quotations unchanged at 25¢ per lb., duty paid. Jobbers are getting 15¢.

ALUMINUM

No. 1 aluminum, 98 to 99% pure, is a little stronger at 61¢ to 66¢ per lb. on two lb. bids, jobbers are getting 75¢ per lb. The market is quiet.

Eastern Metal Market

New York, November 15.

The scarcity of copper for near-by and first-quarter deliveries, and the consequent startling advance in prices are finally narrowing activity. Not since 1873 have prices been at their present level—33c. for spot and 30 to 31c. for first quarter, having been paid. The enormous export sales, more of which are reported to be pending—all calling for future deliveries—have frightened consumers into paying almost any figure for metal they need. Brass mills and electrical companies have been big buyers. It is predicted that 35c. will soon be quoted.

A moderate, but steady business has been done in zinc, and prices have worked upward. No impairment of its strong position is looked for this winter.

Lead has continued quiet but strong.

In tin there have been some exceptionally active days in which brokers sought to cover their contract commitments. Great Britain is more strict in the matter of issuing licenses to ship. The New York price is higher.

Antimony is without feature.

Aluminum is 1c. higher.

The Pennsylvania Railroad has put an embargo on west-bound shipments originating at points east of Pittsburgh, also Philadelphia and other points. The New York, New Haven & Hartford Railroad is restricting shipments to points within its territory, and in each case the iron and steel and metal-working trades are sufferers.

Foundry pig iron is quoted at \$25 to \$26 per ton, furnace, on the Atlantic seaboard. For Southern iron \$20, furnace, is quoted.

Iron and steel pipe have been sharply advanced; black and galvanized sheets are higher.

Ship plates continue in enormous demand, and for forward delivery 4.50c., Pittsburgh, has been paid. For prompt plates, shipbuilders have paid 5.50c., Pittsburgh.

Much interest attaches to the 1917 prices to be announced for Lake Superior iron ore. It is believed that non-Bessemer ore will be \$1 higher, with a still larger advance likely for Bessemer.

COPPER

Sales of spot copper at 33c. are reported, and conservative members of the trade are predicting that the price will go to 35c. per lb. before the week is over. Prevailing prices are the highest since 1873. The enormous export buying, together with the great quantities contracted for by the large domestic consumers, has inspired a general rush to cover future requirements. As for those who are in immediate need of the metal they seem willing to pay any price. The situation is one which many term dangerous. Spot metal is extremely scarce, also that for first-quarter delivery, and there is none too much for the second quarter. Of course, one willing to pay the price can obtain any of these positions, but he has to look long and ardently for it. At the prevailing price an occasional consumer is willing to sell because of the attractive profit he can realize. Buying has been heavy for weeks, both on domestic and foreign account, but it was greatly stimulated by a report first heard November 11 stating that the French government was negotiating for 225,000,000 lb. for delivery in the second half of 1917. On November 6, the day prior to election, an enormous business was done. Since then the number of buyers has narrowed, but there still are interests which appear eager to buy any odd lots they can find. The market is somewhat difficult to quote for a specific delivery for the reason that sales are for varied positions. February electrolytic, on the 8th, sold at 20c. On the next day, prompt sold at 31c., first quarter at 30c., and second quarter at 29.50c. On the 10th, late November sold at 31c. On the 12th second quarter sold at 30c. early in the day,

and 30.50c. at the close. On the 14th, second quarter sold at 30.50c., and a sale of spot was reported at 33c., December at 32c., and January and February at 32.75c. It is a market where changes occur almost hourly. Lake is nominally quoted at the same levels as electrolytic. The London market for spot is higher, the quotation yesterday being £152, against £144 a week previous. Exports of the month are not large, amounting so far to only 7202 tons. Buying in the week just ended is estimated at upwards of 250,000,000 lb., including export and domestic business, not a small part of which was placed on the eve of election day, in fact, some of the producers declare November 6 to have been one of the largest days in their history. Makers of sheet copper have advanced their base to 40 cents.

ZINC

A steady, but moderate business continues to be done, with the brass mills the largest buyers, although exporters also are active. The galvanizers have been doing comparatively little in the market since the price left 10.50c. Two or three influences are giving great strength to zinc, one of which is an advance of \$10 in the price of ore at Joplin, making it \$90 per ton. A producer's representative figures that on this basis it costs about 10.50c., St. Louis, to make spelter. The cold weather has continued to interfere with the gas supply and consequently production, something that will be a factor through the winter. The price of zinc is expected to hold firm, barring slight ups and downs, until next March. Most of the business so far booked is for delivery to the end of the first quarter, although some deliveries in the second quarter are contracted for. Quotations in the past few days have worked upward steadily. The price for prompt yesterday was 11.50c., New York, and 11.25c., St. Louis; for December, 11.50c., St. Louis, and for first quarter, 11c., St. Louis. Exports continue on a large scale, those of the month, 1st to 15th, totaling 6396 tons. The London market for spot stood yesterday at £56, against £53 5s. a week previous. The makers of sheet zinc have advanced their base price to 17c., f.o.b. mill, carload lots, 8% off for cash.

LEAD

Not much can be said about lead. The market continues firm at unchanged prices. Both the leading interest and the independents are asking 7c., New York. At St. Louis the A. S. & R. Co. adheres to 6.92½c., but outsiders are asking 6.90c. Consumers are well covered. Much of the strength of the situation is due to the narrow margin between production and consumption. The London quotation for spot is unchanged at £30 10s. Exports to the 15th totaled 1022 tons.

TIN

Great Britain is chary about granting licenses to ship, and it appears that certain New York dealers and brokers have been caught with insufficient tin to cover their contract commitments. Several of these have been in the market in the past week and have bought large quantities. On the 11th and 13th these interests were active buyers, and on the latter day brokers and consumers bought at least 500 tons, leaving inquiry for several hundred tons unsatisfied. In the buying preference was given to tin aboard steamers that were actually named, inasmuch as this metal seemed more certain to arrive. On the 14th, probably 300 tons was dealt in, ordinarily a heavy day. The quotation for spot tin yesterday was 41.12½c., New York. Prices have been strengthened not only by the buying, but by the statistics which show that only 500 tons has arrived this month. Alloat is 4202 tons. The leading maker of tinplate has withdrawn its price of \$5.75 per base box and now asks \$6.

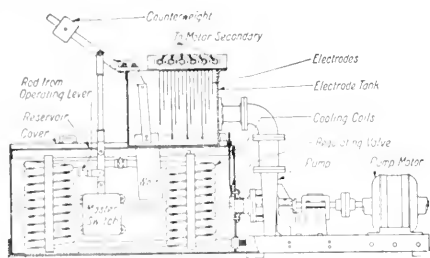
Industrial Notes

Information supplied by the manufacturers.

Liquid Rheostatic Control for Large Alternating-Current Wound-Rotor Motors

The extensive use of electric-motor drive for mine haulage, hoists, dredges, and similar applications brought to the fore the necessity for a controller for large wound-rotor induction-motors that would give wide and accurate speed variation, positive time-limit acceleration, and allow the motor to run at reduced speeds for long periods. To meet these conditions the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., designed the liquid type of control which is shown in the accompanying illustration. These controllers have been in successful operation in various applications for the last four years, and have proved equal to the most severe treatments.

A liquid controller consists essentially of a primary panel and a liquid rheostat. The former is made up of mechanically-interlocked magnetic-contactors for starting, stopping, and reversing the motor, oil circuit-breakers that entirely disconnect the motor from the line in event of an overload, a fused knife-switch for pump motor, and a low-voltage relay for the protection of operator and apparatus against voltage failure. The secondary control consists of a liquid rheostat complete



SECTION OF LIQUID RHEOSTATIC CONTROL.

with brass or wrought-iron cooling-coils for varying the resistance in the motor secondary, a pump and pump-motor switch for the circulation of the electrolyte, and a master switch for the control of the equipment. For plugging service a single lever *H* slot device and two overload relays are used. The two overload relays are mounted on the primary panel and protect the motor from overloads when running, but are short-circuited when plugging the motor. When operating under these conditions the circuit-breaker is set to protect the motor against exceptional overloads and short circuits on the motor, but too high to trip out in ordinary plugging service.

In the type of control shown, the depth of the liquid, in which the electrodes are immersed, is varied. This principle insures smooth acceleration and close-speed regulation of the motor, as an infinite number of steps can be obtained by gradually varying the depth of the liquid. It eliminates objectionable jerks and sudden strains in both the cable and equipment when starting loads of large inertia. The construction and operation of the control is so simple that even an inexperienced operator can obtain good results, and maintenance costs are low, since the electrodes are practically the only parts requiring renewal and these very infrequently. It is of especial value for heavy-duty reversing service, when starting is frequent and the motor is run at reduced speeds. It is furnished for any primary voltage and frequency and for either two or three-phase.

As shown by the diagram, the three secondary phases of the motor are connected to a set of electrodes suspended in the

electrode tank. The operating level is attached to an arm just above the master switch. When the lever is in the off position, the electrolyte, which is a solution of sodium carbonate (sal soda), is at its lowest level. When the operating lever is moved from the off position the contactors in the primary circuit are operated by the master switch and the weir raised. The electrolyte, which is circulated continuously by the pump, rises as the weir is raised. This immerses the electrodes more, decreases the resistance in the rotor circuit, and speeds up the motor. By adjusting the position of the weir the resistance in the rotor circuit is changed and the speed of the motor regulated.

A regulating valve in the pump discharge or intake pipe prevents the liquid from rising in the electrode tank at a rate greater than that for which the valve is adjusted. So the lever may be moved directly to the full-on position while the liquid will raise at the rate determined by the valve setting. The weir, however, is of such a size and design that the electrolyte will flow through the lower compartment speedily enough to take care of plugging when that is practised.

For plugging service the single lever *H* slot device and the two overload relays afford a positive protection against the wrong operation of the lever. To prevent over-travel in hoist work, either single or double-pole hatchway limit switches can be furnished. When the hoists are used for lowering, an over-speed device is desirable. Cam-limit switches form another means of protection, safeguarding against accident due to carelessness on the part of the operator. These consist of a number of switches operated by means of cams mounted on a hexagonal shaft connected to the driving motor or the driven mechanism through a chain and sprocket, or by a worm gear.

The Westinghouse company has sent us a little booklet entitled 'The Worker and the Works.' Photographs show exterior and interior views of the East Pittsburgh plant. Over 25,000 men are employed, receiving \$2,000,000 a month as wages. Sales are over \$1,000,000 monthly. Safety-first is a part of the welfare work for employees, which includes a magazine, club, night school, compensation and sickness funds, and pensions.

Commercial Paragraphs

The A. LUSCHEN & SONS ROPE CO., St. Louis, is now constructing an administration building costing \$100,000, adjoining its rope plant. The factory buildings of this company since 1903 have occupied a 33-acre site in the north-west part of St. Louis, while the offices have been in the down-town district. The new arrangement will result in increased efficiency.

William Cooper Cuntz, general manager and director of the GOLDSBURGH TRUNK CO., of New York, died on November 2, at Amherst, Massachusetts, where he was on a visit for the benefit of his health, which was impaired by an operation for appendicitis a year ago. He was born in New Jersey in 1871 of an old New England family. Mr. Cuntz was a member of 20 well-known societies and clubs in the East. His experience in the steel industry was extensive. He leaves a wife and two children.

A splendidly-arranged catalog, 9 by 12 in., has just been issued by the YUBA CONSTRUCTION CO. of Marysville and San Francisco, California. The frontispiece is a photo of the factory, and part of the globe showing that this firm's dredges are working in Alaska, California, Idaho, Montana, Oregon, Colombia, Siberia, and the Philippines. During the past three years Yuba dredges in California have dug 100,000,000 cu. yd. of gravel at a cost of 4.5c. per yard. The factory is in the centre of the dredging districts of this State. Special steel wearing parts have made Yuba dredges last a long time. Good photos show part of the shops, details of dredge parts, construction progress and launching of Yuba No. 15—the largest in the world—and boats in operation in many regions. Notes are given on the Yuba ball tractor, and cost of dredging.

EDITORIAL

T. A. RICKARD, Editor

OUR New York letter on the metal market will be found particularly interesting this week, especially in its references to copper.

CARRANZA'S government in Mexico has shown a better disposition lately toward American mining interests. The export tax on precious metals has been reduced and the threatened forfeiture of idle mines has been postponed.

SEATTLE has been selected by the Secretary of the Interior as the site for a mining experiment station to be operated under the direction of the Federal Bureau of Mines. Congress provided for three such stations, one of which was to be in the North-west. Tucson is to have the south-western station and Fairbanks will get the one intended for Alaska.

CYANIDE has risen recently so rapidly that the quotation now is 70 cents per pound, on new contracts; while on old contracts the price is a little less than half the figure mentioned. The chief manufacturer of this important chemical dislikes to enlarge his plant, believing that the existing market conditions cannot persist for long. The embargo on shipments from Europe has curtailed the imports of cyanide, so that the American supply is wholly inadequate.

LEAD mining in Missouri is the subject of an article by Mr. Sydney H. Ball. It is the kind of article that the editor is glad to receive and to publish, for it is written with a care and a skill that render even a dry technical subject easily assimilable by the enquiring reader. The ore deposits of Washington county, Missouri, are among the more interesting of the concentrations of metal that furnish scope for small-scale operations, and the economic geology of them has a scientific interest quite as great as that of the bigger accretions of ore in other regions.

FIRST AID to the injured in and about mines, is one of the most important of the many humanitarian innovations of recent years. Friendly contests between rival first-aid teams of important mines have come to be a feature at official gatherings of mining engineers and others engaged in the mining industry. These contests have a direct tendency to promote efficiency and speed in the rendering of aid to the injured, and are a decided relief from the traditional prize rock-drilling contests that have so long been popular. Whether these latter

trials of skill were of any real value is extremely doubtful. Rarely, if ever, was the man who won the prize as the champion driller on county-fair day the best miner, nor was he ever known to so far forget himself as to give any demonstration of his skill except when drilling for a prize.

AN editor discovers that he has critical readers as soon as he permits a blunder to appear. In a recent issue we spoke of the gold in the world available for monetary purposes as worth eight billion dollars and stated that this was equivalent to the amount of gold in a cube of 60 feet. This is incorrect. Taking the density of gold at 19.32 and a cubic foot of water at 62.42 pounds, we find that one cubic foot of pure gold weighs 1465.569 pounds Troy. This, at \$20.67 per ounce, equals \$363,519.734. Dividing 8,000,000,000 by this figure, we get 22,007.058 cubic feet, or a solid cube of pure gold measuring 28.023 feet on each face.

DISCUSSION this week starts with a most timely letter on 'Electrolytic Practice' by Mr. S. E. Bretherton, a metallurgist of much experience. He gives some useful hints to the Western mine-owner and dwells upon the better market offered to the purer product of the electrolytic refinery, particularly that of zinc. On this branch of the subject he has more to say, reciting some of his own experience at the Afterthought mine in California. Mr. William Hague, managing director of the North Star Mines, testifies to the usefulness of the summer training-camp and endorses the plea made by Mr. A. H. Babcock in our issue of the 18th inst. Mr. T. Nipper writes from board ship, but in his remarks he is not much 'at sea.'

TALES of fabulous deposits of native copper have been brought to San Francisco by Capt. C. T. Petersen, of the Stefansson expedition. The explorers found the Eskimo sewing their clothes with needles made of copper. This was on Banks island, which is about 550 miles due north of Great Bear lake. This story recalls the finding of native copper in the Coppermine River country by Samuel Hearne in 1770, by others since, and finally the expedition of Mr. George M. Douglas, who, in 1911 and 1912, penetrated into this remote region and made a careful investigation, as related in his delightful book 'Lands Forlorn.' He and his friend, Dr. August Sandberg, a Swedish geologist, found copper in the amygdaloidal portion of basaltic flows and in beds of conglomerate, resembling those of the Lake Superior country. No rich ore was discovered, but the samples

brought home suggested possibilities of large-scale exploitation in days to come. Similar copper finds have been made on Bathurst inlet, on the west side of Hudson's bay, 500 miles to the east. Evidence accumulates to indicate a wide distribution of copper in the Arctic regions of this continent, and we do not doubt that some day a thorough exploration will be made in search of orebodies rich enough to warrant mining on a large scale. Among those that are making millions out of the current inflation of copper shares there should be two or three willing to find the money required to equip an expedition to explore the territory between Hudson's Bay, the Coppermine river, and Banks island.

COST of living is a phrase that covers a multitude of extravagance. The present rise is due largely to our way of living, which has been in no way modified by the exigencies of an industrial crisis. "Wilful waste makes woeful want" is an old proverb that applies to this country today when the rate of personal expenditure knows no check and the exhaustion of natural resources to take advantage of abnormal markets is being hastened apace. While prices of staples rise there is yet no sign of a diminution in the buying. New York is given over to an orgy of dissipation and the new millionaires are spending money like drunken sailors. Half the world is in mourning and the other half is indulging itself in riotous luxury. Is this our notion of 'preparedness' for the crisis that must come after the War as surely as there was one when the War began? It behooves us to be serious in times like these.

MAJOR-GENERAL GOETHALS, Governor of the Panama Canal Zone, has replied to sundry criticisms and predictions unfavorable to the great work for which he is sponsor. In his annual report, now made public by the War Department, he complains that some of these criticisms have affected the commercial rating of the Canal and tended to diminish traffic. This traffic is small enough to need some apology, for the average of a ship per day each way is far below all reasonable expectations. Only 91 vessels engaged in the American coastwise trade used the Canal during twelve months. General Goethals asserts that there is much ignorance on the subject of slides. There may be, but criticism of the Canal engineering is not confined to those that are ignorant. For instance, nobody in California supposed that slides affect the entire length of the cut, but it is worthy of note that the portion of the Canal thus affected is slightly less than one mile. However, a mile of ground, if it starts to move, is an engineering obstacle of the first rank. General Goethals has no patience with the report of the commission sent to Panama by the President in October last year and he protests against a report by the professor of geology in Lehigh University, Mr. Benjamin Le Roy Miller. His main objection is based on the fact that Professor Miller spent only "three or four hours" in his examination, but that may have sufficed to give him the data necessary for an opinion. The objection smacks too

much of the criticism of adverse reports on a mine because a competent engineer did not spend as much time on it as a stupid man might find necessary before he could formulate an opinion. The quotation from Professor Miller's report is much like the description given by Dr. John C. Branner, for whose opinion the mining profession has a high respect. As to ex-Senator Thomas Kearns and his theory, it surprises us that General Goethals should pay so much attention to it, unless it be that the theory put forward by the ex-Senator gives the General a chance to ride off the field with a flourish. We find nothing in the extracts from General Goethals' report, as published in the daily press, to allay our anxiety concerning the safety of the Canal or to encourage the expectation that the slides can be stopped at an early date.

SEVERAL daily newspapers have doubled their price and a number of magazines have been compelled to increase their rates of subscription on account of the higher cost of paper. Most of this is the result, not of a scarcity of wood-pulp, bleach, and other materials used in the manufacture of paper, but of a cinch—in plain words, of a combination between the manufacturers to raise prices, on the excuse that they expect to be compelled to pay more for their crude material. The allegation that such a conspiracy does exist has been made by the American Newspaper Publishers Association, and it is to be probed by the Federal Trade Commission on December 12. The declaration of huge dividends by the paper manufacturers is fairly good evidence that they are not suffering from any shortage. The press ought to be able to protect itself against imposition. We feel confident that it will be disclosed that the paper market, like many others, is being manipulated under cover of the so-called effects of war; like the man who raised the price of eggs and imputed the blame to "the War." On being pressed for an explanation, he stated that he had to send the shells to Europe! "War is shell." Many of the greedy gentlemen that are taking advantage of our necessities at this time have no better reason for their extortionate demands.

ORDERS have recently been received at the local office of the Federal Bureau of Mines to the effect that the San Francisco office, in the Custom House building, will be no longer a distributing-point for the publications of the Bureau. Only such publications as happen to be on hand at the date of this order are to be delivered to those making application for them. Also the chemical laboratory that for several years has been maintained in the Appraiser's Building, in San Francisco, has been discontinued. The latter may possibly be spared without working a hardship on any one in particular, as chemical analyses and experiments can perhaps be made to better advantage at one of the larger and more fully equipped experiment-stations, but it seems unfortunate that the public on this side of the continent should be compelled to write to the main

office of the Bureau of Mines at Washington for any of its publications that may be wanted. The U. S. Geological Survey maintains an office in the Custom House building and we see no reason why that distributing agency should not be utilized by the Bureau of Mines as well. It is high time to save some of the public money that is wasted by the scattering of administrative energy. Both bureaus are in the Department of the Interior. We hope that the Secretary, Mr. Franklin K. Lane, will be made aware of the facts and act in the matter with his usual good sense.

Copper 'Investments'

In our last issue we published a letter from Mr. Ira B. Joralemon on the efforts being made to gull the public with iridescent copper prospects. Since then we have received a good example of the sort of propaganda used by the peddlers of shares in wild-cats. In the Albuquerque Journal we find a prospectus that offers stock in "a company in the right location, namely, about three miles north of the United Verde and one mile west of the Santa Fe railway." The second fact is more significant than the first; three miles is far enough from a celebrated mine to thin out the orebodies to a *hilo*, while a mile from a railroad is what is usually called in a prospectus "facilities for transportation." The inevitably "well-known engineer," whose name we forbear to mention, states that the surface of the property shows "lime and chert flows," suggesting an unusually high temperature at the time of eruption, for chert contains a good deal of silica, we believe. This is bad enough, but the Albuquerque type-setter breechates the text of the "well-known engineer," so that he is made to state that the "underlying"—that's a good word—formation is "shist and diorits" in which "quartz and calceide matrix" are on the rampage. Indeed it is the delirious trimmings of geology and must have caused a rush for the "pre-organization stock" offered at 10 cents per share—going fast—"buy it now, before it is too late." As a final argument the simple-minded "investor" is told that "it is on the same fault with the United Verde and the United Verde Extension." Perhaps it is. Mr. J. P. Morgan lives in the same street as a pea-nut vendor; it may be at the other end; and real-estate values fade out at that end; but still it is in the same street. "The same fault," yes, the same as that of some high-class share-brokers in New York that are circularizing suggestions about copper shares as an 'investment.' Such a suggestion is as arrant a bit of humbug as that of the disseminated wild-cats. Nobody who buys copper shares when the metal is selling at 33 cents is participating in an 'investment.' Buyers of such shares expect to sell soon at a profit, leaving the other fellow to 'hold the bag.' Plainly, it is a gamble. Even if a mine can pay reasonably on 15-cent copper, a sane man does not buy the shares when copper is more than twice as high, for the simple reason that he can obtain his 'investment' at

much nearer an investment price when the market breaks, as break it must when the big rush for copper is abated. On the whole, the wild-cat incubator has more of our respect than the experienced financier in his marble-decked offices in the New York sky-scraper that talks to the public in dignified phrases at this time concerning the "investment worth of copper shares." That is bunco-steering and nothing else.

The Bureau of Mines

We take pleasure in publishing the larger part of an address delivered before the American Mining Congress by Mr. Van. H. Manning, the Director of the U. S. Bureau of Mines, on the subject of 'Federal Aid to Mining Efficiency.' It was eminently proper that Mr. Manning should avail himself of the opportunity to inform the public on such an important matter and that he should select the Congress as his medium of transmittal. This is the most valuable function that the Mining Congress can perform; it is a convention of those interested in mining as a national industry; at its annual meeting all the various elements contributory to the welfare, efficiency, and expansion of mining are represented, without distinction of class or profession. The technical societies serve their particular purpose and chambers of commerce have their own usefulness, but it is fit and proper that once a year the representatives of the mining public should assemble to make known the wants, legislative and industrial, of the great business to which their energies are devoted. We are informed that the recent meeting at Chicago fulfilled this purpose and that the proceedings were full of interest, particularly to those engaged in coal mining, which, naturally, absorbed the larger share of attention at this particular meeting. Mr. Manning's address should be read by every good citizen engaged in mining. The comparison between the financial aid given to the two basic industries is one that is often made and the latest figures emphasize the curious discrepancy in the allotment of Federal support. Undoubtedly one reason, not mentioned by Mr. Manning, why the miner obtains less help than the farmer is the general supposition that mining is more speculative than agriculture and that those engaged in mining make money more freely than those occupied in tilling the soil. The mining 'game' is one that the average legislator usually regards as bringing its own gains and losses through methods that do not call for special endowment. This misconception is fostered by the spectacular side of speculation in mining shares. Miners readily turn their property into stock companies whereas farmers rarely seek to distribute their risk in a similar way. Nevertheless, the relation of the mining industry to the State is becoming better understood, particularly the many forms of mining that do not lend themselves to stock speculation and represent something akin to what is called an 'investment.' However, even the uncertainties and risks incidental to most forms of

metal mining should not debar a full measure of Federal aid and support, for similar vagaries of fortune characterize other national industries, such as fishing, that receive adequate assistance. With the competition for appropriations between the various branches of the Government the citizen need not sympathize; the mere fact that one department gets a larger helping from the pork-barrel than the other is not a valid grievance, until it is proved that the larger appropriation is ill spent. It is a great pity that financial support should be dependent upon annual lobbying at Washington. Under ideal conditions it should be as unnecessary as it is undesirable for members of a scientific service to have to curry favor with legislators in order to obtain the votes of money required for the proper performance of their work. Sometimes one is tempted to wish that a direct tax, say, of only 4%, could be levied on our mineral production for the maintenance of the scientific bureaus and that the income thus obtained could be divided in equal proportions, so as to end the annual scramble. One matter that requires attention is the persistent duplication of work, particularly the double collection of statistical information by the two Federal bureaus and by the various State bureaus. Another is the lavish printing and distribution of stuff that has little value. It has become too easy to print inconsequential collections of data for the purpose of swelling the apparent output of a bureau and for the personal gratification of minor officials. We receive a good deal of printed matter from Washington that goes into the waste-paper basket with a celerity more eloquent than any criticism. If any commercial publishing-house were to distribute its output in the same reckless fashion, it would soon go into liquidation. Much of the lavish distribution of papers, circulars, and statistical compilations is intended to impress the uncritical public with the activity of the particular bureau or service from which it emanates. The consequence of most importance is the wasting of good money that is needed for other and much more useful purposes. These suggestions must not be taken as indicating any general criticism of the good work being done by the Bureau of Mines. Our readers are well aware of the successful development of the 'safety' campaign and the consequent saving of human life in the mines of the country. Investigations into the hygiene of mining have proved highly effective in promoting the health of the workers. In technology, much has been done to stimulate the profitable exploitation of the secondary minerals and a number of technical investigations have been brought to the point of fruition, yielding information already adopted in current operations. From this assistance the mining industry will benefit, but we confess that we are jealous of an invasion of the field of engineering practice and hope that keen discrimination will be shown in the selection of subjects for experimentation and study so that individual initiative will not be subjected to unfair competition. We would like to see the development of a policy whereby the individual technician could get assistance, rather

than competition, from these Federal bureaus. In this and kindred matters we look to Mr. Manning, who follows so worthily in the footsteps of Holmes, to steer between violent extremes. The U. S. Bureau of Mines has won public support and will, we feel assured, continue to deserve that support.

Mergers

The New York financial press contains references to 'merger rumors' or schemes proposed for consolidating various mining companies, chiefly those exploiting copper. The Utah, Braden, Kennecott, Chile, Cerro de Pasco, Inspiration, and Nevada Consolidated are among those mentioned. However "nothing definite has yet developed," we are told, because among other deterrents is the suggestion that the Federal government might consider such a consolidation as conflicting with the anti-trust laws. The group of mines mentioned is producing half the copper of the United States or half of what was the world's production before the War. Another 'merger,' said to be under consideration, is a consolidation of the Alaska Gold and the Alaska Juneau. For this rumor there is no reason, we believe, except the wish to obscure the disappointment of the promoters, more particularly the brokers, behind the Alaska Gold enterprise. It is extremely unlikely that the controllers of the Alaska Juneau will entertain the idea. A little consolidation, like Scotch and soda, is an excellent tonic, but we have seen the idea stultified in South Africa and in other regions during the last decade. The recent agglomeration called the Kennecott Corporation has no excuse except the facility that it afforded for a little financial ledger-remain. Most of the big consolidations on the Rand served to disguise the union of poor mines or disappointing properties with the richer producers, thereby enabling the 'big houses' to rid themselves of junk. Moreover, the confident predictions of a lower working-cost, to follow such consolidations, have proved fallacious. There is an economic limit to the size of any unit, whether it be a mine or a mill. There is also a limit to human capacity. By merging mines one after another and creating a huge complex of operations, a point is reached where no engineer, however competent, can exercise anything like close supervision. His duties have to be deputized to extinction, so that the administration becomes unwieldy and inefficient. In short, super-mines are easier to make than super-men. To join the Utah Copper to the Chuquibambata will produce no economy; both are quite big enough to tax the executive ability and the technical supervision of any man. One being in Utah and the other in Chile, the object of consolidation is not obvious outside a stock-broker's office. If the idea is to give a broader basis to the operations and a greater stability to the output, then we reply that the consolidating of all the copper mines in the world—unless accompanied by an arbitrary monopoly of the market—would not eradicate the one factor that renders copper mining speculative, namely, the price of copper.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Electrolytic Practice

The Editor:

Sir—After all these years of 'watchful waiting' on the part of the owners of Western mines containing complex ore, called by the smelter men 'refractory' ore, we now have brighter prospects for the future. 'Complex ore' is an ore containing metals that interfere with the recovery of other metals of value, more particularly zinc in a sulphide ore containing gold, silver, and either copper or lead, and sometimes all of these metals in the same ore in addition to considerable zinc. If the proportion of zinc is under 40%, the ore cannot be classed as a zinc ore, and if it could the zinc smelter does not want the other valuable metals. The zinc increases the cost of recovering the other metals, no matter who does the smelting, so that the usual penalty charged over 10% by the smelters, 50 cents per unit above 10% (a unit is 1%) added to the charge for treatment is to be expected. Now, if the penalty on an ore containing, say, 20% zinc equals \$5 added to the value of 400 pounds of zinc lost (360 pounds should be recovered at a value of 5 cents per pound at least); the owner is out \$23 per ton on account of poor metallurgical practice. I feel confident that we are now about to experience a change for the better. First, the large mine-owners who are strong enough to do so and have the mining property to justify, are now installing expensive leaching-plants to recover and market all five metals from the same ore, such as gold, silver, copper, zinc, and lead. The next step will be for these same reduction plants to purchase custom ore and pay for the zinc with the other metals and, instead of penalizing it when over 10%, pay for it. If they fail to do so, some enterprising capitalist will start an independent reduction plant to purchase complex zinc ore, the same as the lead and copper custom smelters are now doing for their ore.

There is one view of the situation that perhaps most zinc-mine owners, who have no reduction plant of their own, have lost sight of, that is, we cannot expect the owners of a mine owning their own complete reduction plant to purchase custom ore while the prices of metals are abnormally high, if they can supply their reduction plant with ore from their own property. When metal prices are low is the time to conserve their own ore-supply and purchase ore from others and at the same time avoid the risk of buying on a high market and selling on a low market. It requires several weeks or months to treat the ore and get the metals sold in the East.

I started to write an article of encouragement to the

Western owner of complex ore but so far I have written on discouraging lines. Now I wish to show how the Western mine-owner of the so-called complex ores (in the past practically worthless on account of their being so difficult to treat) is going to have the advantage over the zinc producers in the Eastern states: The inland zinc-producing States are no closer, from the standpoint of freight-cost, to the New York market; in fact, not as close as San Francisco is with cheap water-transport, now that the Panama Canal is completed.

The West Coast states have much more available water-power for generating the cheap electric current necessary for the production of electrolytic zinc. This electrolytic zinc, on account of its purity, will in time, I believe, drive most of the retort zinc from the market, and others more capable of judging take the same view of the situation. Objection will be made to this statement on the claim that the less pure retort spelter of the East answers the purpose for manufacturing most of the alloys into which zinc enters, but the manufacturers of brass and of paints prefer the pure article; in the one case pure spelter and in the other pure zinc oxide, so that they can always use the same definite proportion of zinc in their alloys and zinc oxide in their paints.

The much despised complex zinc ores of the West will also have the advantage over the Eastern zinc ore in having other metals to share the burden of expense, often enough of these to defray all the expenses of mining, treatment, and marketing. Before closing my remarks on the future advantages that the Western zinc-producers will have over the East, I must add a little boost for the Pacific Coast states, especially California, by calling attention to our favorable climate the year round, without such extreme heat in the summer or such extreme cold in the winter as interferes with the efficiency of labor.

I think it unnecessary to call attention to the troubles the Eastern zinc-smelters are having in the failure of the natural-gas supply for fuel, compelling them to revert to the more expensive coal-fuel. While some of the Eastern smelters claim to pay for the copper, silver, and gold contained in a zinc ore or concentrate, their metallurgical loss is so great that after paying a low rate for the zinc, they offer to pay only for a little more than half of the gold, silver, and copper contents. If they pay for any of these last-named metals, an additional charge is made for treatment. It is not right to condemn these people for such practices, considering the antiquated methods of treatment they are using and compelled to continue to use by force of circumstances.

The Eastern zinc-producer has had one great advantage over the West in the past, before modern leaching methods were commercialized to treat the zinc ore containing other valuable metals: throughout the Mississippi Valley states the ore, although low-grade, is comparatively near the surface. It contains either lead or zinc, easily separated by concentration into clean high-grade concentrate, close to the zinc smelters in the coal-fields, and lower freight-rates to New York, where the spelter is sold.

This difference in freight-charges has been equalized by water-transport through the Panama Canal. The new leaching processes for treating zinc ore do not require the cheap fuel, necessary as a reducing agent, used in the old Belgian retort method, and for power purposes California has cheap fuel-oil in addition to water-power.

No one man or company is entitled to the credit of the wonderful advancement in zinc metallurgy made within the last few years. Several metallurgical chemists have experimented, but most of them lacked the financial backing necessary to prove whether their ideas were right or wrong. Improved methods of concentration, more especially flotation, which eliminates the old fear of making too much slime and also increases the recovery of the metals from the ore in a concentrate, has assisted the beneficiation of all metals. This high recovery of the metals in a concentrate, at a very low cost per ton of ore, not only eliminates most of the minerals that interfere with either retort-smelting for zinc or the leaching process, but also reduces the tonnage necessary for final treatment by the more expensive methods.

The idea of leaching zinc from an oxidized ore or an ore oxidized by roasting appealed to most of us from the start, but we soon learned the danger of forming insoluble combinations with the zinc if the roast was carried at too high a temperature. When roasting zinc ore the temperature must be higher than is necessary for the roasting of either copper or iron ore. Then, after the zinc was in solution, the most serious difficulties were encountered, that is, not only to obtain a pure zinc but also a solid zinc cathode suitable for melting into marketable bars. The problem of precipitating a solid zinc cathode was solved if an absolutely pure zinc precipitate could be obtained, the last traces of iron being one of the most difficult impurities to eliminate. The experience of F. L. Wilson at the Afterthought mine when experimenting with the ammonia carbon-dioxide process was the same, for although our solvent was not supposed to dissolve any of the iron with the zinc and copper, traces would nearly always finally get into the resultant zinc oxide, just enough to make it a little off-color. My own three years' experience as chemist at custom lead smelters when a boy made me appreciate the difficulty of precipitating the iron from an alkaline solution unless it had been previously oxidized from the ferrous state to the ferric, as we made a practice of doing with an oxidizing acid or salt in the laboratory before precipitating the iron with the arsenic, if there was any present. But these expensive chemicals could not be used on a com-

mmercial scale. It was on account of so many more impurities getting into the solution with an acid solvent than with an alkaline solvent that I favored the ammonia carbon-dioxide process, and even then we found traces of iron would finally show up in the zinc oxide.

Frederick Laist, chief metallurgical chemist with Frederick F. Frick for the Anaconda Copper Co., found that manganese ore answered the purpose and patented their ideas in U. S. patents No. 1,167,700 and 1,167,701, issued on January 11, 1916. With the enterprising policy and strong backing of such people as the Anaconda company, combined with their own ability, they finally developed their present zinc-leaching plant on a large scale.

While the Anaconda company was improving its process, the Bully Hill Copper Co. was developing a little different acid-leaching process briefly described in two U. S. patents (No. 1,154,601 and 1,154,602) issued to Otto Best on September 28, 1915. The idea of using manganese dioxide to oxidize the ferrous iron to a ferric iron had been adopted by Alexander T. Elliott of Los Angeles in 1908, as described in his petition to the Commissioner of Patents on September 5, 1908. What he claimed was that ferric salts would dissolve copper and zinc from an oxidized ore, reducing the ferric salts to the ferrous state, and that he re-generated ferrous salts back to ferric by the use of MnO_2 . I spent a few days at that time investigating this process, but was not satisfied with the extraction obtained or the quality of any zinc product we could get from the solution.

Several years ago I was requested to investigate a process in Oakland to recover the zinc with all valuable metals from the Afterthought ore. I was told by the old gentleman who had the process that he used no acid and that his chemicals cost nothing; all that he used was water after a long-time roast. He would neither let me have any of the residue nor explain anything that he used. As he made a mystery of the process, would not let me have any of the residue, and stated that he would not patent his process, I lost faith in the scheme. Had he given me any of the residue, and had we found it to contain some manganese, I doubt if even then I should have suspected that it had been added to the original ore before roasting. It was only recently that a friend of mine who had to investigate some of the work Charles Best had been doing before he died, learned that his secret was the addition of manganese ore to the sulphides before roasting, which helped to oxidize the sulphur, forming a complete reaction to sulphates of zinc and copper, so that after roasting the addition of water would leach out as much as 95% of the zinc and copper from such ore as the Bully Hill or Afterthought mines.

San Francisco, October 25,

S. E. BRETHERTON.

[We thank Mr. Bretherton for his interesting contribution and hope that other metallurgists will feel prompted to discuss the subject. This phase of metallurgy is of the greatest importance in the West where electric energy can be generated cheaply, and where coal is so expensive.—EDITOR.]

Officers Reserve Corps

The Editor:

Sir—I have read the article on 'Engineers for the Officers Reserve Corps,' by A. H. Babcock, appearing in your issue of November 18. Permit me to add a mite to the exhortation at the end of the article. As one of ten or twelve thousand who put in a month at Plattsburg this summer, I have a better conception now of the highly technical training required of an army officer; of the inadequacy of one month's training to make a 'rookie' competent to fill any military position; and of the fearful condition that would result if this nation should become involved in war while it has an insufficient supply of officers and relies on untrained volunteers to make an army. Inheritance of the rights of citizenship in this nation obligates all of us to service. One's feeling of generosity in giving a month's vacation to the country, in undergoing training, soon changes, after contact with Army officers, to the realization that an overdue debt to the nation is being paid in part. Therefore, engineers who can possibly spare the time, should at least allow the Army officers to 'take a crack' at them, so that if they are wanted they may have some military training when called upon. The two weeks' training—and it should be four weeks—demanded each year, for five years, of officers in the Reserve Corps, if it is anything like Plattsburg, will prove a most interesting and a valuable experience; the benefit of the physical training alone being worth all the trouble involved. A regular Army officer makes a very spry citizen out of even a fat man. Engineers should "do their bit" while the going is good.

WILLIAM HAGUE.

Grass Valley, November 19.

[This testimony to the value of the summer training-camp is timely; so is the hint of the duty owed by the citizen to the State, especially by the more intelligent type of citizen, such as the engineer. We hope all of our readers have read Mr. Babcock's article, and that having read it they will appreciate the propriety and privilege of doing their share of service to their country.—EDITOR.]

Regarding Foreign Capital

The Editor:

Sir—The way to obtain the greatest possible utility from foreign capital is to do as the keen legislators in one South American republic are planning to do. Begin by simplifying the regulations regarding the location of mines and their purchase. Allow the foreigner or the foreign company to operate under favorable conditions. In this way, properties that are of absolutely no value to the present owners, on account of the money required to develop them, can be sold to foreigners, who will invest money, employ labor, buy produce, pay freights and duties, and ship copper and iron ore.

When there are enough large companies operating and sufficient jealousy among the citizens of the country, it is a simple matter to put an export duty on all shipments

of minerals or metals exceeding a fixed tonnage. This tonnage will be chosen so that all native companies escape the tax and all foreign companies pay the tax. After the foreigners are once in, they cannot get out, and an income running into the millions can thus be obtained. Of course care must be taken not to take all the profits, or if these are taken, it must be only in cases where the foreigner has hopes of increasing his profits to a point where they will exceed the tax.

There are some statesmen that think, with your correspondent Mr. M. B. Yung, that mines should not be sold to foreigners. This is the condition in Paraguay—and look at the result! With such premises, assume that all of us Westerners decided that too many Easterners were making money in our Western mines, and therefore decided that no one from east of the Mississippi might own mines in our Western States. That would be so fine that those of us in California would carry the plan a step further and decide that only Californians may own mines in California. This would work so well that San Diego county would pass a law allowing only natives of San Diego to own mines in the county. This would help the county so much that the Julian district would copy, and only Julianites might work mines in Julian. Now, as the people in Julian are in exactly the same position that the Chinese and the South Americans are (no money to work their mines) it should be quite clear how rapidly the mineral industry is going to develop in China under Mr. Yung's scheme.

Mining is not exactly what the outsider considers it. The expression 'mining company' is not exactly synonymous with 'good business' though many 'statesmen' seem to think it is (including statesmen in the United States). No, it isn't all profit, as many an investor has learned, to his sorrow.

Once there was a very little boy who had heard his father and mother discussing "putting money into the mine" and the money they would take out of it. Upon his first visit to the property, he had no hesitation in going down the narrow twisted workings, always seeming to be looking for something. When they came to the surface, father said, "Well, son, what do you think of the mine?"

"I didn't think a mine was like that!" he said, hesitatingly.

"What did you think it was like?"

"Why," he said, after some study, "I thought it was a great big machine with two holes in it. One hole to put in a little money and the other hole to take out a lot!"

At Sea, November 5.

T. NIPPER.

THE zinc output of New South Wales has increased greatly the past 10 years. The British government has agreed to take 100,000 tons annually of zinc concentrate from that province during the War and for 10 years thereafter, and also to take 45,000 tons of spelter made in Australia. This will require about 115,000 tons more of zinc concentrate.

Federal Aid to Mining Efficiency

By Van. H. Manning

INTRODUCTION. *On two foundation industries, agriculture and mining, the welfare and prosperity of this country rest. Agriculture is unquestionably still the greatest of our industries, but mining is easily second in importance. The value of the products and the number of men employed by these two industries are sufficient evidence of this fact.

In this country agriculture received aid from the Federal government and the States long before mining, and today, as far as official encouragement is concerned, agriculture is the best organized of all our industries. You will find agricultural organizations in every State in the Union; in addition, there are several great national organizations, any one of which is at all times ready to call attention to the needs of agriculture.

Mining is becoming better organized and a number of organizations, notably the American Mining Congress, are now working in its behalf, but we have much farther to go to reach the stage of organization attained by agriculture. This organization of agriculture is reflected by the activities of the Federal government. With the Department of Agriculture back of this industry and several thousand skilled men looking after its every interest; with Congress for many years educated to the needs of agriculture, it is a comparatively easy matter for agriculture to get what it wants in the way of appropriations.

I have had some comparative statistics prepared concerning the two great industries and some of the conclusions reached are almost startling. According to these statistics, mining is not receiving from the Federal government anything like its just share of the appropriations annually made. The statistics show that if mining were to receive the same consideration as agriculture, comparing the relative value of the outputs of the two industries, mining would receive nearly four times as much as it now receives, or \$8,018,560 instead of \$2,333,075. Another interesting comparison shows that the Federal government in the present year has donated to the farmers one dollar for every \$295 worth of products of the farms. It has donated to mining one dollar for every \$1047 worth of products from the mines.

I am pleased to say, however, that mining is beginning to receive more recognition. Last year Congress passed a law providing for the establishment in several important mining regions of the United States of ten mining-experiment stations and seven mine-safety stations in addition to those already established, but providing that not more than three of the mining-experiment stations

and the same number of safety stations shall be established in one year.

Having thus called attention to the comparative financial aid given by the Federal government to the two great industries, I shall summarize somewhat briefly the work done by the Department of the Interior in its efforts to aid mining. That Department, as you know, includes the two Federal bureaus, the Geological Survey and the Bureau of Mines, whose activities relate almost wholly to the mineral industries.

No other country in the world has such vast and varied mineral resources as the United States. In 1880 the value of the mineral products of this country, according to the Tenth Census, was \$364,000,000; in 1900 the value had risen to \$1,063,600,000; in 1910 to \$1,991,200,000; and in 1915, according to the advance figures of the Geological Survey, to \$2,373,000,000. From 1880 to 1915 the population of the United States increased about 100%, whereas the value of its mineral production increased nearly seven-fold.

But this tremendous increase in production has been accompanied by unparalleled waste, in both the production and utilization of our mineral wealth, with too little regard for the health and safety of the men whose labor converted the natural resources into the commercial products. A people of restless energy, individualistic, eager for immediate success, and having little regard for the lessons of the past, we have indulged in an orgy of hasty exploitation, with the result that already we are nearing the limit of maximum production of some minerals, although the original supply, if wisely mined and utilized, would have lasted us many years longer and would have brought us ten times the wealth. To conserve our remaining supplies, that is, to extract, prepare, and utilize the minerals and ores in such manner as will be of most benefit to the Nation, is not a simple nor an easy task. Our mineral resources are many and extend throughout great areas, occur under widely varying geological conditions, and are subject in large part to State laws that differ greatly.

Evidently no one State should be expected to bear the cost of investigations that are of interest to all the States, and for each State to undertake such investigation would cause much duplication of effort and unnecessary expense.

THE BUREAU OF MINES. Investigations of the causes of mine explosions and the methods of preventing such explosions were begun by the Government in response to a general demand that measures be taken to lessen the loss of life in mining operations. When it established the Bureau of Mines, Congress directed the Bureau to investigate not only mine explosions, but also mine acci-

*An address delivered by the Director of the Bureau of Mines before the American Mining Congress at Chicago on November 15.

dents in general, and the conditions that affect health and safety, and also to investigate methods of mining, treating, and utilizing mineral substances with a view to economic development and the prevention of waste.

For purposes of administration, the investigations conducted by the Bureau are grouped in five divisions: mining, fuels and mechanical equipment, mineral technology, metallurgy, and petroleum, each in charge of a chief engineer.

SAFETY INVESTIGATIONS. The early activities of the Bureau centred about investigations to determine the causes of explosions in coal mines, the methods by which such explosions could be prevented or checked, and the development of safer and more healthful conditions. Consequently, the most notable result of the Bureau's efforts during the past six years has been the arousing of a wider interest in greater safety and more healthful conditions in mines and metallurgical plants, and the gaining of the co-operation and active aid of all possible agencies in the progress of improvement.

The Bureau of Mines makes no claim to having been the first agency to call attention to the high death-rate among miners; nor does it claim it was the first to urge the need of safer methods. It has gladly welcomed the aid of all agencies that have sought to better conditions, and it freely concedes the credit that is due them for what they have done. The Bureau does claim, however, that its work has served to stimulate a nation-wide movement for greater safety in all industries and that the value of this work has been great and cannot be measured in dollars.

Among the results of this increasing safety and health are the saving of life among miners who received first-aid treatment; the enactment of State laws to increase safety, prevent accidents, and lessen waste; and the tendency to demand more efficient inspection in mining and other industrial establishments.

The Bureau has been responsible for a revolutionary change in the use of explosives in coal mines. It pointed out the dangers attending the use of black powder in mines that were gaseous or filled with coal dust, and urged the substitution of what it termed 'permissible explosives,' those that had successfully passed severe tests. In the year 1908 only 2,000,000 pounds of these permissible explosives was used in the coal mines of the United States. In 1915 the amount of permissible explosives sold was 27,350,000 lb., or nearly 14 times as much as in 1908.

By calling attention to the possible dangers attending the use of electricity in mines the Bureau has led manufacturers to devise safer types of apparatus, especially electrical switches and motors, that can be used in gaseous atmospheres without danger of causing explosions by sparks or flashes. Also, the Bureau's activities have led to the manufacture of approved types of hand and cap lamps for miners, by which mining is rendered safer. Several States have followed recommendations for enacting stricter laws regarding electrical equipment in mines. Recently the Bureau has been investigating gaso-

line and storage-battery locomotives for mine haulage.

In co-operation with the Public Health Service the Bureau has investigated the health conditions in certain of the metal-mining districts where miner's consumption, caused by the breathing of silicious dust, is prevalent and where the death-rate from this disease was causing alarm. It has shown the operators and miners the injurious effects of breathing this dust and how, by the proper treatment of the rock-dust, deaths from this cause may be greatly reduced, if not entirely stopped. The Bureau has pointed out how the homes of miners can be made more comfortable and more sanitary, and has already witnessed its recommendations adopted by mining companies and construction concerns.

Some direct results of the safety movement and the workmen's compensation laws have been a saving of thousands of men to their families, a tremendous reduction in the amount of suffering through lessened injuries, and, where men have lost their lives through the hazards of industry, an adequate compensation to sustain the widow and the orphans.

The Bureau sends out to the men in the mines pamphlets called 'miners' circulars,' which tell of the dangers in the mines and the precautions a man should take to avoid injury and disease. The Bureau is issuing a number of these safety-papers for the especial benefit of foreign-born miners, each paper being printed in a foreign language with the English translation on the facing page, so that the miner is enabled to learn English at the same time that he learns the safety-lessons.

Since the Government began its educational work of demonstrating the use of rescue apparatus and of training miners in methods of recovery work and administering first-aid to those injured by accidents, more than 40,000 miners have been trained by the crews of the Bureau's stations and cars. Moreover, as a result of this educational work and of the efforts of men who had received training, nearly 1000 men have been rescued from mines after explosions or other disasters. It is estimated that at more than 1000 mines there are now well-equipped and trained rescue-crews. Interest in first-aid methods is being stimulated by contests between teams representing different mining companies and by teams representing miners' organizations in different States.

The additional safety-stations to be provided under the terms of the act approved by Congress in 1915 will enable training to be given in districts where such training and proper facilities have long been requested.

The Bureau's engineers have been highly successful in developing devices for preventing dust explosions in coal mines. Dusts from hundreds of mines in different coal-fields have been studied and their relative inflammability has been determined. In addition, suggested methods of rendering coal-dust harmless have been tested at the experimental coal mine.

Since the Bureau was created it has kept careful statistics of the number of men killed in coal mines, metal mines, and quarries throughout the country. These

statistics now cover a period of five years and show in the first year, 1911, a total of 3539 killed in all of the coal and metal mines and quarries of the United States, with a death-rate of 3.52 for every 1000 employed. There has been a steady decrease not only in the number of men killed but also in the death-rate. For the year 1915, there were 2970 men killed with a death-rate of but 3.01 for each 1000 employed.

The greatest progress has been made in coal mining. The statistics for the year 1915 show these important conclusions. The actual number of men killed was the lowest in the last eight years. The death-rate for each 1000 men employed was the lowest in the last 16 years. The number of tons of coal produced for each miner killed was the largest in the entire history of coal mining in the United States.

While the year 1915 was the safest ever known in coal mining in the United States, the figures for the first eight months of 1916 indicate that the 1915 record will be eclipsed. For these eight months of this year there are 72 less fatalities than for the same months of 1915, a reduction of 5% from the record of that year. The United States today mines 40% of the world's output of coal, or as much as Great Britain and Germany combined; and its coal mines employ more than three-quarters of a million men.

Recognizing the need of reliable figures of deaths and injuries in the mineral industries, as a basis for determining the hazards, and the rules and regulations needed for safety, the Bureau compiles and publishes annually accident statistics for coke-ovens, ore-dressing plants, and smelters, as well as quarries. Under a co-operative arrangement with all State coal-mine inspectors it publishes a monthly report of coal-mine fatalities, showing their number, cause, and distribution by States. Recently the Bureau published a compilation of all coal-mine fatalities (over 50,000) reported by State mine-inspectors since the beginning of inspection by each State, the figures covering the mining of more than 89% of all the coal produced in the United States since 1807.

MORE EFFICIENT METHODS. Investigations of the problems of miscellaneous mineral technology include safety and efficiency in the preparation and use of the minor metals, rare metals, and various minerals used in the arts. In these investigations especial attention has been given to the possibility of eliminating some of the great waste that takes place and, incidentally, to increasing the efficiency of manufacturing processes and the substitution of domestic for imported products. These investigations have already demonstrated the extent and variety of the losses occasioned by methods in current use.

The feldspar, mica, and kaolin resources of the Appalachian region, and the kaolin resources of the Coastal Plain region of Georgia and South Carolina have been studied with reference to the needs of American potters. The results show that American feldspar is equal, if not superior, to that obtainable elsewhere, that many of the kaolin deposits of the southern Appalachian region yield china clay that is remarkably white and equal in quality

to any imported, and that by a simple and inexpensive treatment under careful control, the immense deposits of kaolin in the southern part of the Atlantic Coastal plain may be made available for china and other white ware.

An investigation of the fuller's earth industry of the country has been instrumental in bringing about a great increase in the production and utilization of domestic earth during the last few years.

In co-operation with the American Institute of Metals and the chemical department of Cornell University, the Bureau of Mines has studied the manufacture of brass and other non-ferrous alloys, with especial reference to preventing the known large waste of metal in both dross and fume, that amount to at least \$2,000,000 a year. Methods of reducing this loss have been pointed out and the development of an efficient type of electric furnace seems assured.

Probably the most striking of the mineral-technology investigations has been that dealing with radium. Through the co-operation of the National Radium Institute a plant was built at Denver for producing radium from the carnotite of Colorado. This plant has been in successful operation for nearly three years, and has produced six grams of radium, which is to be used in the treatment of cancer and malignant tumors. This work has shown that the price formerly paid for carnotite was entirely out of proportion to the value of the mineral contained, and that from Government-owned ore, at least, radium can be supplied to the hospitals of the Army, Navy, and Public Health Service at a cost not exceeding \$36,500 per gram, or one-third of the price that had been asked by foreign producers.

Incident to this work methods for determining radium, concentrating the low-grade carnotite ores, and extracting uranium and vanadium from carnotite were developed.

The metallurgical investigations of the Bureau have been confined chiefly to the smelter-smoke problem, the treatment of low-grade and complex ores, and to the safety and health of employees at blast-furnaces and steel works.

In its endeavor to find ways of lessening damage to vegetation and to animals and of recovering and utilizing substances being wasted in smelter-smoke, the Bureau co-operated with the Selby and the Anaconda smelter commissions. The report of the Selby commission, published as a bulletin by the Bureau of Mines, has received much attention, and the methods of procedure described are being followed in other metallurgical-smoke investigations both in this country and abroad. The Anaconda commission is continuing its investigations. Each commission has been entirely independent of the Bureau of Mines, but the Director of the Bureau has served as a member of each, and the Bureau has co-operated in the investigations. Especial attention has been given the removal of sulphur from smelter-gases.

Investigations of methods of treating the low-grade and complex ores of Utah and adjacent States are show-

ing what new methods are needed or how old methods should be improved to treat millions of tons of ore that lie unworked because of the lack of efficient and profitable methods for saving the contained metals.

Summarized, the principal results of this work have been the development of a brine-leaching process for extracting lead from low-grade and complex ores; the development of a process for the recovery of lead and zinc from lead-zinc sulphides; the application of flotation to the recovery of the lead in carbonate ores; the development of a process for the recovery of zinc from low-grade, complex ores of that metal; and the development of a process for the production of zinc-dust from solutions of zinc.

The investigations of fuels and mining equipment have thrown light on the process of combustion in furnaces and gas producers, and have led to the design of more efficient boilers. The development of an improved type of breathing-apparatus for use by rescue-men in mines after explosions or fires, and the demonstration of the precautions that should attend the use of gasoline-locomotives in mines, are results of this investigation.

The petroleum investigations have shown that the enormous wastes of natural gas and petroleum which have attended the development of gas and oil-fields have not been confined to the gas that escaped into the air, to the losses by fires, and to the evaporation of oil in reservoirs or tanks. The unseen wastes underground through improper methods of drilling and casing wells, by which gas has dissipated into porous beds from which it cannot be recovered, or water has drowned out oil-fields before more than a small proportion of the oil has been obtained have annually resulted in decreasing our national wealth by many millions of dollars.

The Bureau of Mines has shown how these wastes in production can be largely eliminated by improved methods of drilling, especially by sealing porous beds with fluid-mud and by making suitable provision for the control of high gas-pressures. Also, the Bureau has been instrumental in increasing efficient utilization of natural gas, petroleum, and products, through its studies of the recovery of gasoline from natural gas, and the attention it gave to the development of the Rittman 'cracking' process for obtaining gasoline, benzene and toluene from petroleum.

MINING REGULATIONS. In the endeavor to promote safety and efficiency in mining by aiding State legislatures to enact more effective laws, the Bureau of Mines has examined all Federal and State statutes relating to mines and mineral property, and all decisions of courts of last resort in which these statutes have been construed or interpreted. A large bulletin recently issued embraces all the United States mining statutes and is annotated by references to all important decisions. Also, the Bureau is publishing at regular intervals digests of decisions bearing on mining that have been handed down by State and United States courts of last resort. Still another work has been the publishing of proposed rules and regulations for metal mines. A proposed code of

rules to govern the installation of electrical equipment in mines is now in course of publication.

TRAINING OF ENGINEERS. My statement of the work the Bureau of Mines is doing for safety and efficiency in the mineral industries would be incomplete if I did not call attention to the increasing importance of the Bureau as a training-school for engineers and chemists. The services of the expert chemist and engineer are in greater demand today than ever before. This fact has been brought home to me by the number of men who have recently left the Bureau to engage in private work at salaries far larger than the Government now pays. It seems to me that, in considering Federal aid to mining efficiency, we should endeavor to realize the profound influence that these men will exert in making our industries safer and more efficient.

FEDERAL APPROPRIATIONS. For the present fiscal year the appropriations for the Bureau's work are more than 100% larger than for the fiscal year 1911, the first year of the Bureau's existence. Still larger appropriations were virtually promised by Congress when it voted early in 1915 to establish and maintain ten new mining experiment stations and seven new mine-safety stations.

The specific purpose of the appropriations made has been largely influenced by the earlier investigations dealing with mine explosions. Thus, in 1911, 60% of the funds appropriated were for investigating mine accidents, 20% for testing fuels, 13% for general expenses, and 7% for inspecting mines in the Territories and making public reports. As a result, most of the investigations made hitherto have been incidental to mine-safety work and related to coal mining rather than to metal mining.

The appropriations for the present fiscal year provide \$100,000 for mining investigations, and \$70,000 for investigations of petroleum and natural gas. These funds will enable the Bureau to extend its activities in fields that previously have received only incidental attention.

PROJECTED ACTIVITIES. The 10 new mining-experiment stations are to be administered by the Bureau of Mines and are to be located at points in the mining regions where work can be done to best advantage, plans have been perfected for the immediate establishment of the first three of these stations—one in Alaska, one in the Pacific North-west, and one in the South-west.

Also plans have been prepared for developing the 10 stations into individual centres of research, each attacking those problems of most interest to the locality in which it is situated.

One of the great needs of the mining industry is the development of electro-metallurgical processes for the reduction of the base metals. In certain parts of the country, as the Pacific North-west, vast water-power is available and electricity can be generated at minimum cost. There a satisfactory electro-metallurgical process would make commercially profitable the working of millions of tons of mineral deposits that cannot now be worked at a profit.

Of the projected investigations none is of more im-

portance than the study of ventilation in metal mines. Preliminary work and the data obtained in related investigations have shown the scope and character of investigation needed and the Bureau hopes to be able to resume the work in the coming fiscal year.

A study of subsidence, earth-pressures, and roof-supports in mining promises results of great importance to mining and to various engineering enterprises.

In tunneling under bodies of water or in shaft-sinking through water-bearing ground special methods are required. Many cities are driving tunnels under bodies of water for transportation purposes or for water supply, and the Bureau has been asked to give advice, more especially at Milwaukee and Cleveland, where tunnel disasters have occurred. If the funds are made available the Bureau will take up this work, and also study methods of insuring better ventilation in tunnels.

In investigations relating to the iron and steel industry the Bureau will endeavor to develop methods of producing iron and steel with a smaller consumption of fuel, to discover and make available materials now imported, and to develop processes for recovering useful substances from waste products. Among these proposed studies are: An investigation of blast-furnace coke; the use of an oxygen-enriched blast at furnaces; the feasibility of recovering manganese and other ferro-alloys from the wastes of the metallurgical industries; determination of the amount of potash and phosphorous salts available theoretically in the fumes, gases, and slags of the industry, and the practicability of recovering them on a commercial scale.

MINING TERMS. In any proposal recommended as a basis for mining laws that seek to increase safety or efficiency, it is essential that the terms used shall be precise and have more than a local use, or that the terms be carefully defined in the act itself. The confusion and uncertainty caused by using terms of varying significance without defining them is well illustrated in the legal decisions constraining the Federal mining-land law. Recognizing the need of a comprehensive glossary that shall define mining terms with particular reference to their usage in the United States, the Bureau of Mines is preparing a glossary that will contain all available terms used in coal and metal mining; quarrying, and metallurgical practice; geological terms as related to mining; names and definitions of the commoner useful minerals; and also terms used in the oil and gas industry. The work has progressed to such an extent that about 10,000 terms have been arranged alphabetically, and work is being conducted to verify terms selected from former glossaries and to add new terms.

AFTER THE WAR. American industries have met and overcome foreign competition in the markets of the world by reason of the abundance of our natural resources, the ingenuity of our inventors, and the use of improved machinery by which higher wages paid here are compensated by the greater value of the output per man. Today Europe is being forced to increase the per capita output of its artisans, to 'hustle', to use labor-saving machinery

on an unprecedented scale, and to make a larger use of female labor in many occupations. After the War many of the millions now under arms or engaged in making military supplies will be employed in the industries of peace, much of the labor-saving machinery will not be scrapped but will be used in making products that will be needed, and the increased efficiency developed through the necessities of war may be expected to persist for an indefinite period.

In the readjustments that will follow the coming of peace, the American producer will have to consider not only the mineral industries of a different Europe, but also the effect of these differences on the output of mines and works in Canada, Mexico, South America, Asia, and Africa. Clearly some of our old standards of trade are liable to disappear; new conditions will create new problems.

It seems to me that the chief needs of the United States, if it is to meet these new conditions successfully, are a wider and deeper co-operation among our industries, an elimination of factionalism and sectionalism, and the growth of a desire to work together for the common good.

Inasmuch as no plan of co-operation can be most effective unless based on willingness and desire rather than on compulsion, and as everybody can aid in some way, I ask the members of the American Mining Congress to endeavor in their undertakings to bring about the substitution of what has been termed "co-operation in competition" for that intense and selfish competition which has led to ruthless waste of our natural resources and shocking disregard of human life. The Bureau of Mines has sought and seeks your co-operation in all its efforts to benefit the mineral industries and the men who labor in them. Nothing has given me greater pleasure than the manner in which the American Mining Congress and other organizations, as well as mining companies, and miners, engineers, and chemists have responded to that appeal, and I gladly take this opportunity to express my gratification.

But, after all, the work for greater national efficiency is hardly more than started; what remains to be done is far larger than what has been accomplished, and for this reason I hope that you will continue to aid the Bureau in its investigations, offering suggestions or making criticisms as you see fit, and adopting such of its recommendations as you find practicable. Federal aid to efficiency cannot accomplish what it should unless you feel that the Government is endeavoring to help you, and the Department of the Interior and the Bureau of Mines cannot do what they wish to do unless you perceive that behind their efforts to aid efficiency in mining is the desire to advance the welfare of this country and through that to contribute to the betterment of all mankind.

THE United States leads the world in the production of tungsten ores and alloys of tungsten. Before the War, Great Britain controlled the tungsten production and Germany the manufacture of tungsten alloys.

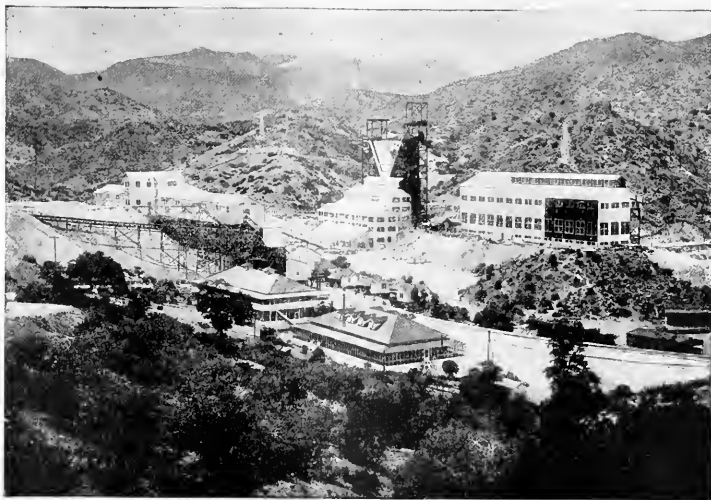


FIG. 4. MAIN SHAFTS, COMPRESSOR-HOUSE, COARSE-CRUSHING PLANT, AND STORAGE-BINS OF INSPIRATION CONSOLIDATED COPPER CO.

Automatic Electric Hoist at the Inspiration Mine

By H. Kenyon Burch and M. A. Whiting

*One of the advantages of electric drive is the ease with which motors can be controlled automatically. In many cases some features of the control are automatic—for example, the rate of acceleration may be limited automatically or the equipment may be stopped automatically at the limit of travel—but the equipment is ordinarily started and stopped by hand. In other cases the motion of the machinery is utilized to start, control the speed, and stop the motor automatically, independently of any operator.

A considerable number of the large mine-hoists now in use have automatic features, particularly protective devices against over-winding, and, in some types of electric hoists, devices for preventing excessive acceleration or retardation. The large automatic hoists discussed in this paper, however, are completely automatic, that is, capable of making their trips without the presence of an operator at the control-levers.

According to circumstances, various advantages may be obtained by automatic control, chief of which are decreased power consumption, increased precision and safety of operation, and decreased cost of attendance. The first step in the analysis of a prospective automatic mine-hoist is to determine whether automatic operation is feasible at all. If men are to be hoisted, or skips changed at levels, the attention of an operator is re-

quired; but under some conditions it may be entirely practicable and advantageous to build the equipment so that, while provision is made for hoisting men or changing levels, ore can be hoisted automatically from any one level. If, however, an operator's attention is required every few minutes for changing levels, hauling men or drills, or for other work requiring hand-control, it is obvious that automatic operation between times will not be of any practical benefit.

For a slow hoisting-speed it may be possible for the skip or cage to pass through the dumping-point at full speed, and a sufficiently accurate stop may possibly be obtained automatically by cutting-off power and applying the brakes at full speed. In this case, either a shunt-wound direct-current motor or an induction-motor may be used. A number of slow-speed automatic hoists are arranged in this manner, and are driven by induction-motors. One equipment of this type used in mining is the inclined hoist for hoisting concentrate at one of the mills of the Arizona Copper Co. This hoist has a rope-speed of approximately 275 ft. per minute.

For higher rope-speeds, at least over 400 ft. per minute, it is necessary to consider carefully the speed-characteristics obtainable from the type of drive proposed. For these higher rope-speeds, it is necessary to slow-down before entering the dumping-horns. Furthermore, the speed about midway in the dump must usually be reduced below the maximum safe speed entering the dump. A reasonably accurate stop is always

*Abstract from *General Electric Review*, a paper originally presented at the September meeting of the American Institute of Mining Engineers.

required; in some cases a total variation of 2 or 3 ft. might not prove prohibitive, but in other cases the stop must be more accurate. For reliable operation, it is nearly always imperative that the automatic-control system shall act in like manner irrespective of load, that is, that the rate of retardation and the position of stopping be nearly the same whether the skip comes up loaded or empty.

There is only one class of motive-power that is inherently suited for automatic operation at high rope-speeds, namely, the direct-current shunt-wound motor with voltage control. The speed-torque characteristics for an equipment of this character are represented in Fig. 1. These curves are typical of this class of equip-

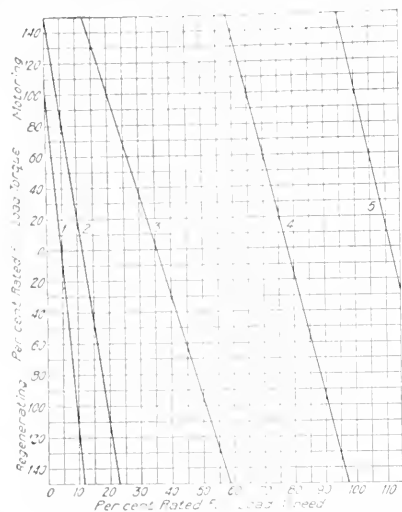


FIG. 1. TYPICAL SPEED-TORQUE CURVES FOR DIRECT-CURRENT MINE-HOIST WITH GENERATOR FIELD-CONTROL.

ment, although the exact slope of the curves will vary slightly in individual cases. Curve 1 shows the characteristic on the lowest, and curve 5 the characteristic on the highest, speed position of the controller for the case selected. The intermediate curves represent three controller points arbitrarily selected out of a total of 30 or more. It will be observed that these curves are nearly, but not quite, parallel. That is to say, the increase in speed in passing from full load to no load is approximately, but not exactly, the same for the various positions of the controller. The deviation from parallelism is due to the effect of armature reactions in the generator and hoist-motor, and may be somewhat different for different cases; but its effect is negligible.

The net advantages (for the purpose of automatic hoisting) obtained by this system of drive are as follows:

As the hoist-controller is moved back toward the off-position the hoist is retarded. In case the net rope-pull is sufficient and the stored energy of the moving system is not too great, the hoist motor simply drops back in

speed to correspond to the reduced generator voltage obtained on the intermediate position of the controller. If, however, the net rope-pull is low (particularly with empty skips in balance), and if the stored energy of the moving system is high, the hoist-motor will invert, momentarily, and will act as a generator, returning power to the motor-generator set. This effect is represented in Fig. 1 by the extension of the curves below zero-torque. In this manner, if the controller is moved toward the off position more rapidly than the hoist tends to come to rest under the influence of the load, the hoist-motor forcibly retards the hoist. If the controller is moved back at the same rate in both cases, the hoist will be retarded to nearly the same speed, and in nearly the same time, irrespective of load in the skip.

It is fairly obvious that the steam hoist is unable to approach closely the speed conditions described. The steam hoist, of course, is capable of retarding a load by working against the steam or compression, but the vital points in relation to automatic hoisting are: (1) for the same throttle opening and cut-off, the speed will vary widely with variation in load; and (2) if the throttle is partly closed or the cut-off advanced to a point at which the skip will enter the dump at a suitable reduced speed, the engine will exert only a slight retarding-torque (if any) to help retard from full speed to the reduced speed at which the engine tends to continue. Most of the retardation must therefore come from the load, which is variable or may even be negative. Furthermore, with a partly closed throttle the final speed at which the engine tends to continue will vary widely with variation in load.

The induction-motor hoist, in its relation to automatic hoisting, has somewhat the same characteristics as the steam hoist. Fig. 2 represents the speed-torque char-

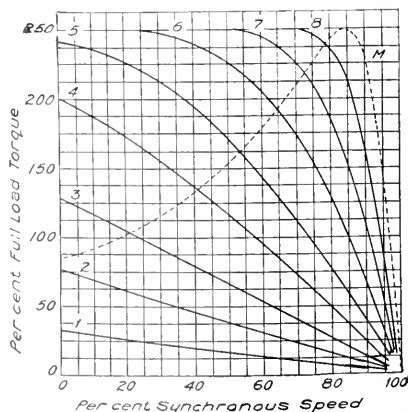


FIG. 2. TYPICAL SPEED-TORQUE CURVES FOR INDUCTION-MOTOR DRIVEN MINE-HOIST.

acteristics of a typical mine-hoist induction motor. In a direct-current hoist, a given retardation can be accomplished in a certain time and distance by the same manipulation of the control, irrespective of the load

hoisted. In a steam or air hoist or an induction-motor hoist, a like retardation of different loads requires different manipulation of the control.

These characteristics indicate, and their further consideration confirms, the conclusion that high-speed mine-hoists that are to be operated automatically must be, in almost all cases, driven by direct current.

When the arrangement of its main shafts was under consideration by the Inspiration Consolidated Copper Co., a concurrence of several conditions indicated the possibility of effecting a saving by hoisting the ore automatically. These conditions were as follows: (1) A direct-current equipment was necessary in any case, as a motor-generator set was required for the fly-wheel equalization as provided in the power contract with the U. S. Reclamation Service. [From hydro-electric power generated at the Roosevelt dam.—EDITOR.] (2) The ore was all to be hoisted from one level. (3) Drills, timbers, supplies, and waste were to be hauled through a drift opening. (4) Men were to be hauled on a separate hoist exclusively. (5) On account of the moderate depth and rope-speed only a moderate retardation effort would be required.

Two three-compartment shafts have been sunk for two independent balanced hoists, each hoist being adequate in an emergency to keep the concentrating-plant operating at practically full capacity. The third compartment of one shaft contains a double-deck man-cage, operating against a counter-balance weight, and the third compartment in the other shaft carries this counter-weight, together with air-pipes, power-cables, etc. Skips carrying $12\frac{1}{2}$ tons are used, and the ordinary hoisting schedule for which the equipment was designed called for an output of 10,000 tons, with a maximum capacity of 14,000 tons, in 14 hours. The hoists are at one end of the compressor-house. No. 2 hoist, in the background in Fig. 3,

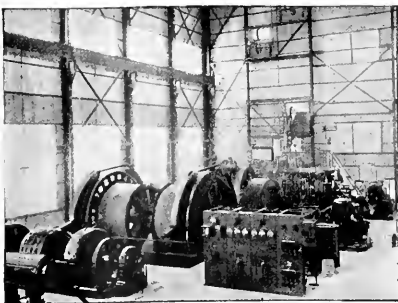


FIG. 3. MAIN HOISTS AT THE INSPIRATION.

handles the skips in the east shaft, which is nearest the compressor-house. No. 1 hoist, in the foreground, handles the skips in the west shaft, the ropes from No. 1 passing above No. 2 hoist over idler-sheaves on the upper deck of the east head-frame, thence over the sheaves on the west head-frame. Fig. 4 shows the arrangement of shafts and head-frames in relation to the compressor-house.

The hoists are duplicates, each consisting of one fixed

and one clutched drum, each 10 ft. diam. by 65-in. face, grooved for 1000 ft. of $1\frac{3}{4}$ -in. rope in one layer. The brakes and clutches are air-operated with oil-cataracts and floating-levers, and the automatic-control system was so designed that the brake-engines could be made practically standard (Fig. 5). The hoists were designed

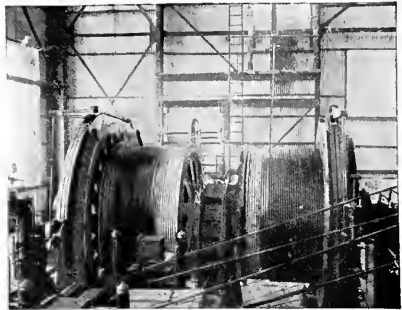


FIG. 5. DRUMS AND BRAKES OF ONE MAIN HOIST.

and built by the Nordberg Manufacturing Co. and the electrical equipment by the General Electric Company.

Each hoist is driven by a 580-hp., 575-volt, 264-r.p.m. shunt-wound motor through a flexible coupling and Falk gears. Power is supplied to the hoists by a 750-r.p.m. fly-wheel motor-generator set, consisting of one 850-hp., 2300-volt, 25-cycle induction-motor, two 500-kw., 575-volt generators, one 20-kw., 125-volt exciter, and a 19,700-lb. 112-in. diam. steel-plate fly-wheel. Each hoist-motor is connected separately to one of the generators and controlled by varying the field of its generator. The fly-wheel is not in any way necessary to the control or automatic operation of the hoists. Its function is to eliminate the peak-loads from the power-system. The control for equalization of the power demand follows along standard lines, using a liquid slip-regulator for varying the speed of the fly-wheel set by varying the resistance in the secondary circuit of the induction motor (Fig. 6).

The depth, from the dump to the chairs under the loading-pockets, is 630 ft. in each shaft; from the collar to the chairs, 557 ft. The rope-speed is approximately 750 ft. per minute.

Before beginning automatic operation it is necessary, of course, that each hoist be properly clutched-in for the loading-level, with one skip in each shaft resting on the chairs below its loading-chute. It is not important which skips are on the chairs, provided, of course, that the operator obtains a 'release' of skips in both shafts before starting the automatic operation. He then introduces the automatic control by closing two small control-switches and locking in two levers, all on the operating-platform. This does not, of itself, start the automatic operation, so that the hoists may be left standing in this manner indefinitely. To start the automatic operation, a master-controller is thrown to the automatic running position, and left there as long as automatic hoisting

continues. According to the positions in which the skips have been resting, one hoist or the other will start. Say, for example, No. 1 hoist starts, hoisting its south skip. The closing of the master-controller just mentioned energizes a small pilot-motor that moves No. 1 hoist controller gradually to the full-speed position in one direction. As No. 1 controller starts away from the off position,

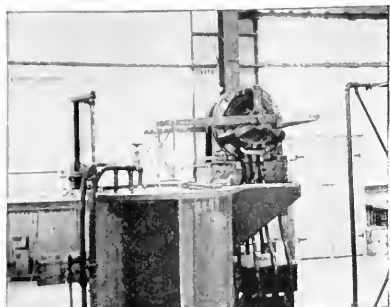


FIG. 6. LIQUID SLIP-REGULATOR FOR REGULATION OF INPUT TO FLY-WHEEL SET.

tion, it simultaneously energizes No. 1 generator-field and actuates a pilot device that releases the brakes on No. 1 hoist. As the controller moves farther toward the full-speed position, it gradually builds-up the generator voltage, thereby accelerating the hoist to full speed.

Toward the end of its trip the travel of No. 1 hoist actuates a pilot-motor that moves No. 2 hoist-controller gradually to the full-speed position in one direction, thereby accelerating No. 2 hoist in a similar manner, to hoist its north skip. Shortly before its skip enters the dumping-horns, the travel of No. 1 hoist, by means of cams, one of which is geared to each drum, moves No. 1 controller gradually toward the off position. This gradually decreases No. 1 generator voltage, thereby retarding No. 1 hoist, and just as its north skip is about to land on the chairs, No. 1 controller comes into the off position. This completes the retardation and automatically applies the brakes. No. 1 hoist stands at rest while No. 2 is hoisting its north skip. Toward the end of its trip, No. 2 hoist energizes the pilot-motor for No. 1 controller so as to start No. 1 hoist in the opposite direction, that is, to hoist its north skip. No. 2 hoist comes to rest in the manner described for No. 1, and rests while No. 1 is hoisting its north skip. Toward the end of its trip, No. 1 hoist energizes the pilot-control to start No. 2 in the opposite direction, that is, to hoist its south skip. The sequence continues in this manner until stopped by the operator, as described later.

A loading system is used underground by which the skips are automatically loaded with a pre-determined weight of ore per trip. The reduction of the attendance required at the foot of the shaft contributes materially to the advantages of automatic hoisting. The automatic loading system can be thrown out of engagement in either shaft so that the hoists may be operated either

automatically or by hand, for purposes of inspection or adjustment, without hoisting any ore.

To obtain a more rapid operation of the hoists, that is, a greater number of trips per hour, when operating automatically a control-switch may be thrown, by which each hoist will be started earlier in the trip of the other hoist, thus over-lapping to a greater extent the trips of the two. If it is desired to run the hoists automatically at fewer trips per hour than normal, this is done by introducing resistance permanently in each generator field-circuit, to give a rope-speed lower than normal.

When the details of design were first considered, one of the chief problems was the arrangement of the control so that the transition from hand to automatic operation, and more especially the transition from automatic to hand operation, might be made without risk or delay, and in a manner easily remembered by any operator acquainted with the equipment. To this end the levers on the operating platform which work the hoist-controllers and brakes for hand control are not disconnected from the controllers or brake-engines when running automatically. Consequently, when the automatic pilot-devices are cut in, and the hoists are operating automatically, these levers move back and forth, as if the hoists were being controlled by hand by invisible operators. When, therefore, the transition from automatic to hand operation is made during a trip, the brake and controller-levers of both hoists are in the correct positions and properly in engagement for hand-control.

The automatic operation can be interrupted at any time during a trip. This is done most easily by throwing the master-controller for automatic operation to the off position, which causes any trip which is under way at the time to be completed automatically, dumping in the usual manner, but prevents the next trip from starting. If the hoists are then left standing, and not operated by hand, all that is necessary to start automatic hoisting again is to throw the master-controller to the automatic running-position (Fig. 7).

Before the construction work at the foot of the shafts and in the bins in the tippie had been completed in detail, it was necessary occasionally to stop an automatic trip without letting it dump. In such an event, or when necessary for any reason to transfer to hand-control before completing a trip, the master-controller for automatic hoisting is thrown to the off position. Without disconnecting or unhooking any other parts the controller lever of the hoist which is running may then be pulled back to the off position by hand, and as the controller comes into the off position the brakes will set automatically. It is now possible to leave the pilot-control of the brakes connected in service, so that the brakes will release and set automatically, as the controller is moved by hand from or to the off position. Or, if necessary on account of the character of hoisting to be done, the automatic pilot-control of the brakes can be cut out, in which case brakes and controller will be controlled separately by hand.

Under all conditions (except when making adjust-

ments in the manner described later), the cams on each hoist-controller remain connected mechanically to the hoist-drums. This cam mechanism thus serves two purposes: (1) in automatic operation it provides the automatic slow-down and stop; and (2) in hand-operation, if the operator does not begin retardation at the proper point, this mechanism will retard the hoist in practically the same manner as when hoisting automatically, thus providing protection against overwinding when operating by hand.

The protective system resembles those of a considerable number of large direct-current mine hoists, of the

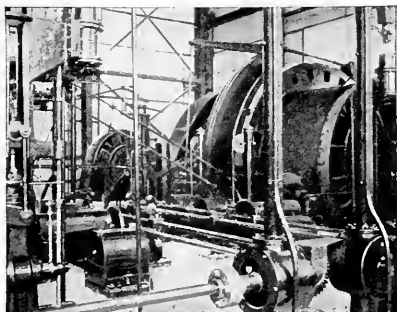


FIG. 7. DEPTH INDICATORS AND AUTOMATIC-CONTROL SYSTEM FOR MAIN HOISTS.

same general type (except the automatic operation) as the Inspiration hoists. In the latter, as has just been noted, the automatic control-system provides against over-winding in hand-operation. An additional set of emergency-limit switches is used, which gives similar protection in case of failure of the automatic control. During hand-operation there are effective, therefore, two complete sets of protective devices against over-winding. For each hoist a hand-operated emergency-switch is provided on the operating-platform, and a similar emergency-switch is located at the foot of the corresponding shaft, by means of which either or both hoists may be stopped quickly from the operating-platform, or the foot. Without appreciable complication, additional emergency-switches may be installed at other points, if desired.

The operation of any one or more of these emergency devices cuts-off power from the hoist and makes an emergency application of the brakes. An emergency, which affects one hoist only, acts on the power and brakes of that hoist only. The failure of excitation or alternating-current power, which affects both hoists, cuts-off power and makes an emergency application of the brakes simultaneously on both hoists.

When unclutching for changing levels, and when taking up stretch of ropes, the adjustments are taken care of as follows:

On the Inspiration hoists it has been the custom, whenever the hoists are to be idle a whole shift, to bring both skips to the collar of the shaft, in order to save

rusting of the ropes. This is done by unclutching just as in any ordinary hoist with one fixed and one clutched drum. If desirable for any reason, either hoist may be run by hand-control either out of balance or clutched in for balance to operate from other levels than the regular loading-level. When clutching or unclutching, the adjustments of the automatic control-system are not touched.

If the shafts are sunk to the ultimate depth contemplated, and the present loading-stations abandoned, the control can be re-adjusted to operate automatically from the increased depth. Without changing the adjustment of the control-equipment, it is not possible to operate automatically from levels differing considerably from the normal level for which adjustment has been made, but the system is capable of modification so as to hoist automatically in balance from any level to the dump, without re-adjustment, all the adjustments being taken care of automatically by clutching-in at the desired level.

Stretch of ropes is taken up in a simple manner which itself is semi-automatic and does not require any measurements. The first time it was necessary, the stretch was taken up on both ropes of one hoist in about 15 min., at the end of which all adjustments were in shape for hand or automatic operation. The method is as follows:

The hoist is run into an automatic stop with the skip on the clutched side resting on the chairs. (This is effected by the cam which is geared to the clutched drum). The controller and cams are now in the proper position for an automatic stop on this side but the rope on this side has unwound farther than normal by an amount equal to the stretch or slack which it is intended to take up. This cam is now uncoupled, but the other cam is left coupled. The hoist is now moved by hand-control just far enough to wind up the estimated amount of slack, and the cam on this side is then coupled up to the clutched drum. This operation takes up the slack on the clutched side and transfers it to the fixed side. The hoist is now run, in balance, into an automatic stop on the fixed-drum side, which lands the skip on the fixed-drum side on the chairs, and brings the skip on the clutched side into the dump. The cam on the fixed side is now uncoupled, and before moving the hoist to take up slack, the other drum is unclutched, so as to leave its skip in the normal position in the dump. The fixed drum is then moved sufficiently to take up all the slack on that side, that is, the stretch of rope on that side plus the slack transferred to that side by taking up the stretch on the clutched-drum side just previously. The cam is then coupled up to the fixed drum and the other drum is clutched-in, which completes the adjustment of both ropes and cams and leaves the hoist ready for operation. It is necessary, of course, not only to take-up stretch on each side, but also to clutch-in at the proper level. During the foregoing procedure, after unclutching one drum as described, the same movement of the other drum which takes up the slack also makes the necessary correction for level.

The east shaft was ready for operation before the construction work had been completed in the west shaft. The ropes were put on No. 2 hoist, and for purposes of test and for a thorough try-out of the system, both hoists were operated automatically, No. 1 hoist running automatically as if in actual service, but without any ropes on the drums.

Both ropes were on No. 2 hoist and both skips were hung in the east shaft by the morning of July 25, 1915. During one shift on that day, after marking the ropes and the drum-flanges, the automatic control and depth indicators were coupled to the drums, the shaft and tippie clearances were checked, cams adjusted for automatic retardation and stop, and 18 skips of ore hoisted by hand-control, using the cams for automatic retardation but not using complete automatic operation. The following day, between 8 a.m. and noon, adjustments for complete automatic operation were made, and 44 loaded skips were hoisted automatically. The adjustments were refined somewhat at a later date, but those made during the first 45 minutes of automatic operation worked well.

The same morning in which the equipment first operated automatically, the accuracy of stop was observed for 12 consecutive trips, that is, six trips each way. The total variation between maximum and minimum was 4 in. of rope-travel. After a few weeks of intermittent operation, similar observations were taken. In 20 consecutive trips (10 each way), the total variation between maximum and minimum was only 1.5 in. of rope-travel in one direction and 1.25 in the other. During this time the ore hung back in the loading-pockets on one side, so that six of the trips included in the above figures were made empty. It is significant that this variation of 1.5 in. is only 1% of the distance traveled per second at full speed of the hoist.

To operate two hand-controlled hoists, either steam or electric, of the size and importance of these, would require at least two operators per shift; and according to practice in some mining districts, an oiler would be employed in addition to the two engine-men. For the operation of these two automatic hoists there is required only one operator, who is able to attend to the oiling and to whatever hand-operation of either hoist may be necessary on his shift.

In conclusion it may be said that the application of automatic mine-hoists will always be limited by the fact that operation cannot be truly automatic, except where the conditions of hoisting are reasonably uniform. In other words, where under prevailing conditions, the attendance of an operator is required practically continuously throughout the shift in order to change levels, hoist or lower loads out of balance, or hoist men, it is impossible to realize any practical advantages by operating automatically during the short periods of hoisting ore regularly from any one level. On the other hand, entire uniformity is not necessary in order to make automatic operation practicable. As an illustration, consider the case of a main hoist serving a few levels, and

an auxiliary hoist in the same hoist-house handling all men, timber, supplies, waste, etc., for all the levels served by the main hoist. Conditions of operation may possibly be sufficiently favorable so that if the main hoist is arranged for automatic operation (or for semi-automatic control from the level-stations by the skip-tender), the operator for the auxiliary hoist will be able to take care of the hand-operation required on the main hoist. It may reasonably be anticipated that from time to time various mine-hoisting problems will arise in which the possibilities offered by automatic hoisting should by no means be dismissed without investigation.

Flotation Oil From Sage-Brush

The clearing of land of its sage-brush is ordinarily accomplished by means of a tractor pulling a frame made of railroad rails. This breaks off the bushes so that they can be collected and hauled to a central point. With the average 4-ft. stand of brush in south-eastern Nevada the yield per acre is about 7 tons of brush. The cost is about \$1 per ton for cutting and collecting the brush to a central point. The cost of destructive distillation of hard wood is in the neighborhood of \$8 per cord (4000 lb.) of wood, or about \$4—possibly \$5 per ton of wood. The sage-brush is more bulky than the wood, and it is best to count on a distillation cost of \$5 per ton. That would make the total cost of treatment of each ton of sage-brush about \$6 with a yield of 80 lb. of tar. This would mean 10 gal. produced at a cost of \$6, or \$0.60 per gallon, or 7.5c. per pound. This is high but is comparable with the present price of pine-oil, of which sage-brush oil seems to be the full equivalent, if not the superior. With most ores, less than 0.5 lb. of sage-brush oil should be needed per ton of ore.

There is one other source of income from the products of the sage-brush, namely, potash, which in carefully burned brush ashes amounts to 15 to 20% of the total weight. Most of this was soluble in water.

About 10,000 gal. of steam-distilled pine-oil is being used every month in the United States for flotation purposes and more would be used if the price were lower. If sage-brush oil could be produced for 40c. per gal. it is probable that the market would jump to at least 1000 gal. per day. With this would be produced 3000 to 4000 lb. of potash, an amount which is much less than 1% of the total consumption in the United States. If the oil could be produced for 25c. per gal., there is no reason why its use should not amount to 10 times the consumption of the oil at a 40-cent rate.

AT THE MILL of the Babilonia mine, Nicaragua, lime costs from \$40 to \$50 gold per ton delivered at the mine. It is paid for according to its content of available CaO, which seldom is more than 40%. Costs are high owing to scarcity of labor and the present high price of supplies, especially zinc and cyanide. The tonnage for July has been increased from 1525 tons to 1800 tons and it is expected to remain at that figure.

The Lead Mines of Washington County, Missouri

By Sydney H. Ball

In this day of large tonnages and efficient machinery it is interesting to visit the lead region of Washington county, Missouri, where mining methods of a century ago prevail.

This is not only one of the oldest mining regions in the United States, for Renault and his French followers began work here in 1720, but for a number of years at least, it was the most important mining district in the country. Washington county's production to date of lead ore, and a little zinc ore, amounts to \$6,800,000. This production has varied greatly from year to year, increasing with new discoveries, high war-prices, droughts, and crop failures.

Washington county is situated in south-east Missouri from five to thirty miles west of the disseminated-lead belt. Topographically, the region is a plateau, the flat rocks of which have been trenched by numerous streams to a maximum depth of 500 ft. Certain distinct hills are composed of pre-Cambrian granite and rhyolite.

The following rocks, named from youngest to oldest, and all of Cambrian age, according to E. R. Buckley,* rest upon the rhyolite and granite:

	Thickness
Potosi formation	400 ft. or more
Doe River limestone	47 " "
Derby formation	39 " "
Davis shale	169 " "
Bonnetterre limestone	366 " "
Lamotte sandstone	250 " "
Granite or rhyolite basement	

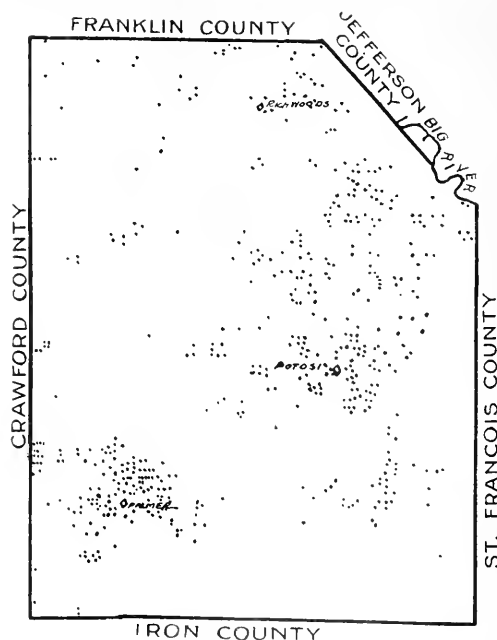
All of these formations at various places are in unconformable contact with the granite and rhyolite. The sedimentary rocks are flat or gently flexed, and normal faults of considerable displacement are common.

Practically all of the Washington County lead has come from the Potosi limestone, although a little has been obtained from the other sedimentary rocks. The main ore-horizon of the Potosi is from 600 to 1000 ft. above that of the disseminated lead which has made south-east Missouri the premier lead district of the United States. It is probable that no particular stratum in the Potosi is throughout the whole county especially favorable to mineralization. Locally certain more soluble beds are so, but the orebodies are primarily related to the present surface and only secondarily to the more soluble beds of limestone.

The map shows that the county contains a vast number of small lead mines, a 'digging' producing 50 tons of ore being considered locally of importance. Some of the larger mines, or groups of mines, have, however, produced from \$1,000,000 to \$1,500,000. The mines are

particularly abundant around the villages of Potosi, Palmer, and Richwoods, the Potosi group having produced perhaps 55% of the total output, and Palmer perhaps 35%. The accompanying map does not show, by any means, all of the diggings in the district.

The orebodies are either residual or lode, the former, of course, being derived from the latter. The lodes can be classified into crevice deposits, pipe-veins, and breccia-fillings. The crevice deposit is a vertical tabular body of ore, the 'gash-vein' of Whitney. In depth these orebodies pinch, as the joint along which disintegration had occurred tightens. In instances cross-veinlets extend



MAP OF WASHINGTON COUNTY, MISSOURI

from the main crevice at right angles following a secondary joint. East-west and north-south crevices are most common. These deposits are occasionally in sets, the ore having been deposited in several parallel joints.

The pipe-veins are semi-cylindrical orebodies lying in a horizontal plane. They are from three to eight feet wide and average six inches thick. There is usually one main 'pipe' of ore that fills a semi-cylindrical hole in the limestone caused by solution of a favorable-limestone bed along a joint. Many minor pipes lead off from the main one, following joints, at, or nearly at, a right angle to

*E. R. Buckley, Mo. Bur. of Mines & Geol., Vol. IX, pt. II, 1908, p. 19.

the main pipe. Systems of pipe-veins may occur at several horizons in the Potosi formation, one above the other. Excellent examples are the Flint Hill and Parole diggings, and a map of the latter by H. A. Wheeler, of St. Louis, forms plate 119, in Part II, of Buckley's report, previously cited. In some instances pipe-veins have been followed horizontally to points 150 ft. below the surface, constituting the deepest workings in the district. The orebodies of the third type are vertical tabular masses of ore cementing either fault or solution breccias.

The residual deposits, or 'clay-workings,' as they are known in the district, are the orebodies just described, from which the enclosing rocks have been more or less completely dissolved by surface waters. The galena of the crevice deposits still frequently remains in a vertical position. Immediately above the bedrock there is a considerable mechanical concentration of lead ore. If solution has been incomplete, the so-called 'tumbling rock' formation of the native miners is found, in which the lead ore occurs between, although usually detached from, boulders of flint or limestone. In the early days some placer galena was recovered from the stream-beds.

The lead deposits are particularly common on hill-slopes, from which, however, they may extend back underneath the plateau.

The original sulphides include galena, zinc-blende, pyrite, and marcasite; also a little chalcopyrite. Galena cubes are usually rounded through solution and are partly altered to cerussite, which in some instances is white and crystallized, and in others is a gray powder. In many mining districts the value of zinc-carbonate has long remained unrecognized, but James T. Hodges states that in this locality cerussite was for many years thrown on the dump and that only in the 'forties were the dumps hand-picked for it. Anglesite is probably associated. The galena usually occurs as small cubes disseminated in 'chalk-tuff,' although in instances it is found in 'ball-tuff.' In the old days lead in large cubes was found in some cavities. Zinc-blende alters to smithsonite, and pyrite or marcasite to limonite, and rarely to hematite. Chalcopyrite alters to chalcocite and malachite. Barite is the common gangue-mineral, and this occurs either as 'ball-tuff,' a conical aggregate of large tabular crystals, or as 'chalk-tuff,' a finely crystalline aggregate. Gypsum (the 'isinglass' of the miners) appears to occur only with residual lead, and doubtless formed comparatively recently in the clay. Calcite ('glass tuff'), is by no means uncommon in the district, but usually is not closely associated with ore. A substance frequently accompanying the ore is the 'yellow paint' of the miners, a heavily iron-stained, rather hard, yellow clay.

The sulphides and original gangue-minerals were usually deposited in cavities, although in certain of the rare fault-breccia deposits the sulphides, in part, replace limestone. Smithsonite, a secondary mineral, also replaces, to a certain extent, limestone along fractures. The primary minerals are usually rather well crustified, and from the limestone, chert, or crystalline quartz walls

outward, the ordinary order is: iron pyrite, or marcasite, zinc-blende, and barite with galena. The reverse sequence, indicating however the same order of deposition, is found on some of the stalactites. Sometimes, next the rock, partly formed pyrite or marcasite crystals and aggregates have barite between them, and the galena crystals are incomplete and enclose barite. Further, in rare instances, a pyrite crystal is isolated in the barite itself, indicating that the depositing waters were not always as distinct as casual observation would indicate. Certain members of the series may be absent, as at Madden Hill, near Palmer, where galena is plastered directly on chert. Of the two types of barite, 'ball-tuff' is older and is sometimes covered by a coating of 'chalk-tuff,' the two contacting sharply. Due to the predominance of one mineral over others, some prospects are lead mines, others zinc prospects, and still others, barite producers.

That these lead orebodies, with the possible exception of some of the breccia deposits, were deposited by descending meteoric waters is indicated by the fact that at comparatively shallow depths they pinch out. Stalactitic masses of altered iron sulphide, galena, and 'chalk-tuff' are common on the dumps, and old miners report that all were found pendant from the roofs of openings. The source of the lead is unknown, although it was originally doubtless disseminated in the Potosi or some overlying formation. That the sulphides and barite are much younger than the flint, and the crystalline quartz covering it, is indicated by the crustification mentioned above, and also by the fact that the ore occurs in fractures in the flint and quartz. As to age, the orebodies are believed to be geologically young, and for the most part, to be contemporaneous with the present, or a comparatively recent, topographic cycle.

The miners around Palmer are Americans, the grandsons or great-grandsons of Kentucky or Tennessee mountaineers. Those at Old Mines north of Potosi are descendants of French miners, some of whom arrived in Missouri about 1720. Among the older men French is still frequently spoken. For at least three generations both Americans and French have been miners, and the mining methods are to a considerable extent those evolved in Missouri. A few, however, trained in mining, were among the early French settlers. Sixty years or so ago a number of Cornishmen emigrated to the district, and a few miners have drifted in from other regions. Prior to the Civil War certain 'diggings' were worked by negro slaves, some being continuously employed in mining, others being sent into the district in winter, after the crops were harvested. At the present time the descendants of Kentucky and Tennessee mountaineers, Cornish miners, French adventurers, and former negro slaves work amicably in the same diggings.

The wants of these people are few, and the standard of living not high, from \$1 to \$1.25 per day being considered a fair wage. While many have drifted to the large mines of St. Francois county, others prefer to be their own masters, and will inform you gravely that their

earnings in the shallow diggings average better than the \$3 or \$4 obtainable in the disseminated-lead mines. Of course some few, when in bonanza, for a time do well, but as an average their earnings are much less than \$1 per day. However, the pleasure of being your own master has distinct advantages, and days in bonanza when \$5 or \$6 or even \$10 were made, are much less easy to forget and more pleasant to remember than days of disappointment. The work-day is a short one, and it is rarely that both partners, two being the common number, arrive at the shaft before 9 o'clock, and at least one is usually gone by 3 o'clock in the afternoon. No work is done on Sunday, and on Saturday the day is spent at the local store discussing politics and the latest lead strike. Many reasons are sufficient to stop work: too much wet weather; too dry a season; too cold weather; or too good a chance to work for a short time for day's wages. Perhaps during the year 175 to 200 rather short days' work is the average. If one has luck it is the custom to stop work until the money is eaten up, then to run an account at the village store, if possible, until one again gets into bonanza. Possibly if longer hours were consistently observed, from \$1.50 to \$2 a day might be made by the more skillful miners.

Mining is done under a leasing system, the payment being variously arranged. In many instances the company owning the land demands a royalty that may vary from 10 to 20% of the lead ore mined, and 15% of the zinc ore; or the miners are required to sell their product to the owners of the diggings at a price that nets on its re-sale a handsome profit on the St. Louis lead price. In the more prosperous days of the diggings a company weigher with bar-scales and wagon, went daily from one 'digging' to another, weighing the day's product and giving a ticket accepted at the company store in goods or money. The lead ore was hauled to one of the small furnaces then so common in this district. At the present day all country storekeepers in the vicinity buy lead and zinc ore at a price considerably higher than the company pays, and either take out the royalty to be later paid to the property owner, or pay all to the miner, who is expected to settle with the land-owner. Rarely, if ever, does the owner of the property fail to receive his royalty. In the boom days the discoverer of a new 'digging' was permitted to stake off a claim twice the size of that allotted to later comers. The discoverer's claim might be 100 to 200 ft. square. The size of the plot also increased with greater depth to the ore-horizon, and claims in which the ore occurred in rock were perhaps five times the size of those in clay.

In prospecting, the well-known 'mineral blossom' (flint covered by transparent quartz crystals) so characteristic of the Potosi limestone, showed the old miner he was on the lead-bearing formation. If this was not present, there was little use of further search. He then sized up the topography, choosing some hill-slope that suited his idea of a promising mineral district. The streams were carefully searched for galena pebbles, and if found, they were followed up-stream until they dis-

appeared, at which point the hillside was trenched. 'Chalk-tiff' was also considered a good indicator, particularly if it contained cubic cavities, indicating that once galena had been a constituent thereof, as were yellow clay ('yellow paint') and limonitic iron ore. 'Ball-tiff' was believed to indicate a pinching out of the deposit, or barren country. A summary of the conditions favored by the old miners 75 years ago, is given by James T. Hodge.†

"Throughout the several counties which are occupied with this formation (limestone), the miner recognizes a proximity to the fissures by the abundance of the peculiar red clay of the hematite iron ore, and of the botryoidal and mammillary masses of quartz rock, and the exact position of the fissure itself is often indicated to his experienced eye by a slight sinking of surface and an east and west or north and south line of brushes or plants which have deep sinking roots and choose a situation where they can send them deep down into the clay. Still these guides are not always sure, for men used to the business often spend a year or more in 'prospecting,' that is, in sinking experimental shafts or following a fissure in hopes of its yielding a rich return of ore, and all without success. But by continuing their work, if their means allow of it, they seldom fail of finally striking a 'lead,' the sale or working of which repays them for all of their labor."

The residual or 'clay' workings are mined by sinking round pits four feet in diameter to bedrock, where the lead ore is notably concentrated. At the ore-horizon the clay is undercut, and the ore removed to a safe distance from the pit. When the pit becomes dangerous, another hole is begun, perhaps 15 ft. from the centre of the first pit; the process is continued until an area sometimes 40 to 100 acres is riddled. The tools used are a short-handled shovel, and pick; when the hole is over eight feet deep a hand-windlass and bucket are added. Horse-whims, and even small steam-hoists, have been introduced on a few of the deeper workings. The ladder in the deeper holes usually consists of a tree on which a few stumps of branches have been left. Pumps are practically unknown, and if water (usually encountered at a depth of from 70 to 100 ft.) interferes with mining, work is usually stopped. The deeper shafts (the deepest around Palmer being about 150 ft.) are square, about four feet in the clear, and in instances timbered in the clay with small pine-lagging. Work usually stops at solid rock and even in it the amount of dynamite used is small, as the partly decomposed limestone usually crumbles to a lime-sand upon being struck. It was but 35 years ago that black powder was discarded, and rumor has it that at Flint Hill, some 70 years ago, the good old Roman method of building a fire on the rock and then throwing cold water on the heated stone was practised. As one of the miners remarked: "That seems like a right hard way to mine, don't it?" From the bottom of shafts, drifts usually 4 by 4 ft. in the clear are run. Two men will sink a round shaft in clay 10 to 12 ft. per day to

†*Am. Jour. of Sci.*, Vol. 43, 1st series, 1843, p. 57.

depths of 25 to 40 ft. and will sink and crib a square shaft 5 to 6 ft. per day; and drive 8 to 10 ft. per day. In the rock they sink from $1\frac{1}{2}$ to 1 ft. per day. The corresponding costs per foot are about 17 to 20c., 24 to 40c., 20 to 25c., and \$2.50 to \$5. No figure can be given of the cost of one ton of mined and cobbled galena, but in instances it is as low as \$5 to \$15.

The ore as it leaves the mines is a mixture of galena and barite. The coarser ore is cobbled by a half-pound hammer with a horizontally set chisel-point, called a 'pickawee,' a corruption of pick-a-way. A light sharp tap with this usually separates the two minerals. The finer mixtures are thrown on the fire where the 'ball-tiff' (barite) breaks down into sand and the galena cubes are easily picked out. The 'chalk-tiff' needs a hotter fire and is less successfully treated in this manner.

Most of the dumps have by now been 'scraped' many times; that is, their surface has been carefully raked over to find any galena left by the earlier miners. The dumps, however, keep some of the more industrious boys of the district in modest spending money.

Washington county produces about one-half the barite of the United States, the centre of activity being Potosi. It has been stated that barite is the common gangue of the shallow lead deposits and it also occurs in deposits by itself with little or no lead. Barite is rarely followed into the hard rocks, as, on account of its low value, it is only profitably mined in residual clay, where, against bedrock, due to its insoluble nature, its concentration is intensified. It is mined, as is the residual lead, in the shallow diggings already described. The barite with the adhering red clay is spread out to dry and is then placed in a sort of cradle—a box mounted on rockers, the bottom of which consists of an iron plate with half-inch holes punched in it. Violent rocking jars off the clay, which drops through the holes in the cradle. The buyers usually pay for the 'tiff' at the various diggings and haul it to the railroad. As the price obtained is low, barite diggings are rarely situated more than six miles from the railroad.

DIATOMACEOUS EARTH, which is made up of remains of minute aquatic animals, is a light earthy material resembling chalk or clay. The hardness, the minute size, and the angular shape of its grains make it an excellent metal-polishing agent, and heretofore it has been largely used as an abrasive in the form of polishing powders and scouring-soaps. Of late, however, according to the U. S. Geological Survey, the uses of the mineral have been considerably extended. It is used by sugar refiners for filtering or clarifying; as an insulating packing-material for safes, steam pipes, and boilers; and as a fire-proof building-material. In the United States it is used in the manufacture of records for talking machines. In Europe it has been used in preparing artificial fertilizers and in the manufacture of water glass, cements, artificial stone, paper, sealing wax, fire-works, papier mâché, and other articles. A total of 4593 tons of diatomaceous earth was produced and sold in the United States in 1915.

Types of Asbestos

*Three types of asbestos fibre are recognized—cross-fibre, slip-fibre and mass-fibre. Cross-fibre (chrysotile) asbestos occurs in veins with the fibres extending transverse to the strike of the vein. Usually the fibres are approximately perpendicular to the inclosing walls, frequently they are more or less oblique and occasionally they are curved or abruptly bent. Slip-fibre is found along fault planes, often accompanied by slickensides, and the direction of the parallel fibres records the direction of displacement. The amount of displacement is usually small. Slip-fibre asbestos is commonly distributed in thin layers that are not as a rule continuous for any considerable distance, but occasionally it is found in masses a foot or more in thickness. All gradations are to be found between the cross-fibre and slip-fibre types. Mass-fibre asbestos occurs in fibrous bundles or groups varying in size and orientation. The fibres may be parallel but are usually divergent and often radiating. In the type occurrence at Sall Mountain, Georgia, mass-fibre asbestos makes up practically the entire rock mass. Anthophyllite has been reported as occurring in all three ways, and it is the only variety of asbestos known to occur as mass-fibre. The asbestiform varieties of tremolite and actinolite are practically limited to the slip-fibre type.

Chrysotile easily withstands temperatures of 2000° to 3000° F., while with some varieties a temperature of 5000° F., produces no visible effect. At red heat it gives up water and becomes brittle. Anthophyllite under the same conditions remains practically unaltered. Tremolite and actinolite fuse at somewhat lower temperatures, while crocidolite fuses so easily that it is useless for many purposes where asbestos is commonly employed.

Chrysotile is readily attacked by relatively weak acids; being decomposed with the separation of silica; the amphibole varieties, especially tremolite and anthophyllite, are very resistant even when subjected to the action of concentrated acids.

MINERS operating hydraulic placer mines, and those operating in open-cuts commonly break up boulders and large masses of rock by the method known as bulldozing, but actual experience has shown that it is far less expensive in most cases to shatter these boulders and large rocks by block-holing with the hammer-drill. To bulldoze effectively a big rock requires from 4 to 10 sticks of dynamite, whereas the same work can be accomplished with one or two sticks if a hole or two be first drilled in the rock with a hammer-drill. At the mine of the Placer Gold Mines Company, near Atlin, B. C., the cost of breaking up boulders in 1915 was reduced about \$1200 over the cost during the season of 1914, an amount almost equal to the expense of a Sullivan compressor and two 40-lb. Sullivan drills installed expressly for the purpose of block-holing boulders.

*Abstract from Trans. A. I. M. E., New York meeting, February 1917.

Black Sand of the Pacific Coast

By Herbert Lang

The problem of the black sand has been with us for a long time and has been attacked by many investigators, usually with poor results. The work done has been mainly of a desultory nature, due, no doubt, to the scattered state of the deposits, which are not, as a rule, either large enough or regular enough in tenor to warrant large-scale operations. However, conditions now are such as to favor further examination and perhaps development, among these conditions being the unexampled rise in the price of platinum, a metal that is not infrequently found in the black sand. Possibly some of our idle prospectors, whose future is giving their friends so much concern, may find it to their interest to turn their steps that way, the more so that the examination of this class of mineral deposit involves comparatively little expense or trouble.

At the outset we have to bear in mind the differences between the two great classes of such deposits, namely, the beach or sea sand, and the river or stream sand. The latter is present in variable quantity in all placers. The first noticeable difference is the great diversity in size of grain—the sea sand not being mixed or associated with the coarse gravel and boulders characteristic of stream placers. On the other hand it contains much finely pulverized material scarcely coarser than wheat-flour. While black sand, properly so-called, is distributed through all placers, and is found in large quantities in some, as a rule it occurs only in small patches and never in amount sufficient to necessitate special metallurgical arrangements for its treatment. The old-fashioned methods of washing, applicable to placer work in general, have been found equally adapted to treat the comparatively restricted collections of black sand. Along the beaches, however, the black sand is found at times in such great quantity as to justify improved methods of treatment. It would only be advisable to make such improvements in the event of finding large deposits, growing larger by constant addition from the original source.

Beach sand is generally deposited free from the boulders with which it must have been at one time associated, and forms a comparatively homogeneous mass, the particles of which do not vary widely in size. In samples that I have screened, and that have been derived from widely separated beaches, the size of grain varies from 30 to 200-mesh, although the dry sand yields occasionally a small amount of even finer dust. The sand, of course, is made up of hard particles of the rocks from which it was derived by erosion, and we find in it quartz, garnet, olivine, zircon, and other silicates, together with magnetite, chromite, titaniferous iron and hematite, along with a very little gold, and once in a while a little platinum. One ought to emphasize the scarcity of the gold and platinum, because the impression has prevailed for a

long while that this sand, or at least a considerable part of it, is rich in gold, but which, owing to some fault of Nature, cannot be successfully recovered. Nothing of the sort is true; for while there are occasionally found some isolated areas of a few square feet, or more likely a few ounces of material that will yield a respectable assay, the average is very poor indeed, and I question if the beaches, even those upon which work has been long carried on, will average more than 10, or at most, 15 cents per ton in gold. Averages, of course, are what we are after in an inquiry like this, and time must not be wasted in chasing sporadic occurrences of rich material that may be reported.

The origin of the beach sand has been much discussed, some observers arguing that because of the presence of the gold it must have had a different origin from ordinary sand, and that the precious metal must have been brought to the ocean by rivers eroding distant auriferous formations. Others, with more reason, maintain that they were formed in the usual manner, by the erosion of the adjacent country, and that the sand is merely the more resisting portion of the rocks. The association of gold proves nothing one way or another, excepting that its form, which is peculiarly thin and flat, militates against its origin in ordinary quartz veins. It doubtless came, like the other constituents of the sand, from the eroded rocks near-by. Platinum is known to originate in basic rocks containing abundance of pyroxene and peridotite, and accordingly it is not surprising to find that metal most abundant along shores abounding in serpentine, a derivative of those rocks, as along the coast of southern Oregon and northern California.

The casual wayfarer sees nothing in these beaches that he has not seen in those of other sea-shores, neither as to their extent or their character. Even on closer examination they appear the same. One notices here and there small areas of darker sand, indicating a concentration of some of the constituents in a confined space; but this is not uncommon on any beach. Magnetic iron, which characterizes certain beaches, is found everywhere in natural sand, and even in fine soils and silts. Nevertheless, it is the magnetite, with some other associated heavy minerals, that is the surest indication of precious metal in beach sand.

Nature, in wearing down the rocks and pulverizing them into sand, performed, as has been frequently remarked, a process of concentration affording a source of wealth, somewhat ambiguous, some will say, but still a source of wealth. Her method has been likened to that employed by man in the milling and dressing of metallic ores. But the parallel is not exact. Nature, indeed, did

the crushing, with the production of oversize, sand, and, doubtless of much slime, which last has disappeared, having been spread on the floor of the ocean, to help in building new continents. She laid down the sand, however, where it remains accessible in enormous amount; but forgot to size it. It is much as if we were to attempt concentration without putting screens into our mill. We know what equal-falling grains are, and we know that we may have a small grain or particle of gold, a larger particle of magnetic iron, and a still larger particle of quartz that will fall through or be driven about by currents of water and land together every time they are moved. This is characteristic of sea-beach sand universally—it is composed of masses of equal-falling grains of a great many minerals varying much in density, but all moved by the waves in the same way. While the waves run the grinding continues, grains of the sand are worn smaller; are sorted and removed, and new associations are formed. In some way, very hard to understand, the grains of black sand are sometimes brought together in large quantity, and doubtless the white ones are also; but no one would notice that. Why this happens I do not know, nor have I even seen an explanation. We cannot imagine that they were always thus together. Whatever be the reason, the waves sometimes make collections of dark grains, segregating them by themselves for a time, only to disperse the collection when the next storm comes. Along the bluffs that front the northern coast you may see as many as twenty layers of black sand interstratified with as many white or gray. But these layers are the edges of short lenses, which thin out and disappear within a few feet, to be succeeded by others. Most of the black layers are quite thin—an inch or two, only, in thickness. We find the same condition if we sink pits or bore-holes in the beach to test the deposit. We may cut a hundred different layers of varying quality in sinking 50 ft., especially as regards the gold content. Variability in composition indicates a similar variation in gold content; whence we may find comparatively rich portions, carrying perhaps 50 cents worth of gold per ton, lying within a few feet of totally barren white sand, as one would infer from what has been already said, is more likely than not to be the poorest of all.

Gold is found as a rule associated with the denser and darker minerals of the sand, such as magnetite, ilmenite, hematite, and chromite. As between two samples of sand, the darker will almost invariably be the richer in gold. Furthermore, in a given sample, there is a peculiar relation in size of particles, the darker and heavier being likewise the smaller. This peculiarity arises from Nature's omission to screen the sand—a vital proceeding in wet concentration. The natural and obvious thing to do, then, is to perform this operation, instead of attempting to extract the gold from the mass of equal falling particles surrounding it. Screening of the sand is effective in collecting all the gold particles, and the whole or the major part of the dark minerals, in a much diminished bulk. I have obtained interesting results by screening many samples of such sand, varying widely in

composition, from material containing but few dark particles, to aggregates made up almost wholly of heavy minerals. By adapting the size of screen-mesh to that of the sand, we may make as many separations as we like. A typical sand may contain particles ranging from 30-mesh down to 150 or finer, and in such case the whole of the magnetite, the ilmenite, etc., will probably pass the 80-screen, and the most of it the 100. Hence an ordinary auriferous sand, containing, say, 15% of heavy minerals, may easily be concentrated so that those minerals along with the gold will go into one-fifth of the original bulk. This fact is of great importance in a rational scheme of metallurgy. It will be noticed that the grains staying on the coarser screens are exclusively white or gray, consisting of quartz and the light-colored silicates, while, as finer screens are employed the product passing through is darker and darker. The gold, being in a fine state of subdivision, stays with the finer sand, and at the end we have a comparatively small quantity of richer material to treat. This simple method of concentration, which after all only supplements Nature's operation, would, of course, be effective only on sand containing a comparatively large proportion of white grains; for if the deposit consisted of magnetite alone there probably would be no concentration by the screening method, since the particles of any single mineral collected in one spot are apt to be nearly of the same size. Some experience in the actual washing of the sand is necessary to enable one to appreciate why the simple sluicing of the natural sand is such an ineffectual operation when it is designed to catch the gold. It is evident that material repeatedly concentrated by Nature and delivered to hand in assorted and equal-falling grains cannot be separated effectively by a repetition of the process. What Nature has done on a great scale is feebly imitated by man, with his puerile rockers, long-toms, and sluices, but to little purpose indeed. It is also evident that in view of the poverty of the sand, that its treatment, profitably, must be on a far greater scale than hitherto known, and with better directed and more comprehensive processes.

Although the impression has got abroad that the gold in black, and especially of beach, sand is difficult to treat metallurgically, the contrary is the case except as regards amalgamation. A great deal has been said, which it is not necessary here to repeat, about the existence of a "coating" on the gold, which renders it "rebellious," or "refractory," or something, so that mercury, and perhaps chemicals generally, have little effect. But the fact is, the gold of black sand is perfectly amenable to cyanide and to chlorine, and furthermore, the ordinary constituents accompanying it are perfectly inert toward those reagents. Should sand be found in quantity and of a quality to warrant the installation of a plant, using either cyanidation or chlorination, there would be not the slightest difficulty in recovering the gold profitably. Smelting has been suggested as a promising means of beneficiating the sand, especially of the heavier kinds, doubtless with the idea in mind of using it as profitable

flux, to take the place of basic material. But this suggestion must have originated under the belief that the black particles are exclusively magnetite. Were it mainly so there is no question that it would serve as a flux, and in case the gold tenor were sufficient, it could be employed with profit. Analysis, however, shows the presence of too many deleterious minerals, including the most of those above named. No one would desire to add either titaniferous iron or chromite to his smelting mixture, for reasons known to every metallurgist, and it goes without saying that silica and the silicates would prove, though for a different reason, an undesirable addition to the furnace burden.

Proposals have been made from time to time to employ the sand as an ore of iron, from which to manufacture that metal, and especially steel. The suggestion could hardly have been made with a knowledge of their actual composition, however, since it may be easily understood that the presence of chromite and ilmenite, would effectually bar the success of such a proceeding. It is only necessary to use a magnet to discover that in almost every case a large number of the black particles are not magnetite, while a few blowpipe tests will reveal the real character of the non-magnetic portion. Analyses of many samples of black sand may be found in 'Mineral Resources of the United States' for 1905. The data published are valuable, but like much that is printed by the Government bureaus are ill digested, and are not brought into correlation with actual mining.

The examination of beach-sand deposits is generally confined to panning occasional samples from the surface; it is only exceptionally that anyone takes the trouble to drill the deposit systematically after the manner of those who investigate dredging ground. One deposit of 200 acres of sand on the Oregon coast was carefully bored, however, but with disappointing results; as instead of a content of \$4 per yard, as was alleged, the highest assay was but 60 cents per yard, and many assays showed no trace of gold. As the gold is entirely free, its connection with the associated minerals being wholly physical, the pan or batea serves perfectly well in skilled hands for obtaining an adequate idea of the quality of the material. Skill, however, is necessary, since the gold has a strong tendency to float off. The panner finds it necessary to wet the sand carefully in his implement first, and then to keep the pan and its contents covered with water at all stages of the operation. So marked is the tendency of the gold to float when dry that at one time I thought it feasible to employ this tendency as an aid in concentration. If the dried material is thrown upon water, the gold, and with it considerable dust, floats and can be gathered up by suitable means, forming an enriched product, which might be called a 'concentrate.' Whether this principle could be reduced to practice remains to be seen. If by this means or by screening, or by a combination of them, there could be secured a product sufficiently rich to pay for cyaniding there would be a chance for establishing an important industry. Others have suggested the use of magnetic concentration to free the gold-

bearing material from at least one of its constituents, preparatory to the application of some process of gold extraction; but this would not seem to promise much in view of the general composition of the sand.

I conclude therefore:

1. While isolated tracts of small extent are comparatively rich, running in some cases, as reported, as much as two or three dollars per ton, most of the deposits carry but a few cents in gold per ton.

2. The sand must prove valueless for steel-making, unless, which is most improbable, masses of pure or nearly pure magnetite shall be found, large enough to be worked commercially, and in favorable localities. The fine-grained condition of the sand would be an obstacle to its industrial utilization for this purpose.

3. Although a few miners are even now making a precarious living by washing beach sand along the northern coast, where it is richest, no regular and important industry has been, or will be, built upon the crude methods of sluicing there practised.

4. A rational scheme for their working must involve some form of concentration, to be followed by the application of some process more effective than amalgamation.

Flotation and Dividend Payments

As is well known, the Minerals Separation company has a suit against J. M. Hyde, really the Butte & Superior Mining Co., in the United States Supreme Court. This is an appeal from a lower Court in the case of alleged infringement of M. S. flotation patents, and a decision is expected at an early date. At Butte, last week, Minerals Separation made an effort to prevent, through injunction proceedings in the Federal District Court, before Judge Bourquin, further payment of dividends by the Butte & Superior company and the proposed consolidation with the American Zinc, Lead & Smelting Co. It is probable that a bond of sufficient sum to insure Minerals Separation against any loss in case it wins its present suit with Butte & Superior will be asked by the Court. The Butte & Superior company denied the right of Minerals Separation to ask for an increased bond, now \$75,000, but maintained that the latter company was not entitled to any bond to secure possible judgment in view of present status of the case.

The Judge said the whole question seemed to revolve around whether or not a bond should be required after the Circuit Court of Appeals had reversed his decision in the Hyde case, which found that oil flotation is an infringement of the M. S. patent. In asking an increase in the bond, Minerals Separation stated that since the first decision in the case, dividends aggregating \$13,098,288 have been distributed to stockholders of Butte & Superior. Official reports filed in Court showed that flotation has netted Butte & Superior over \$15,000,000. Butte & Superior denied that it was to dispose of its properties to American Zinc.

Mining in Nevada

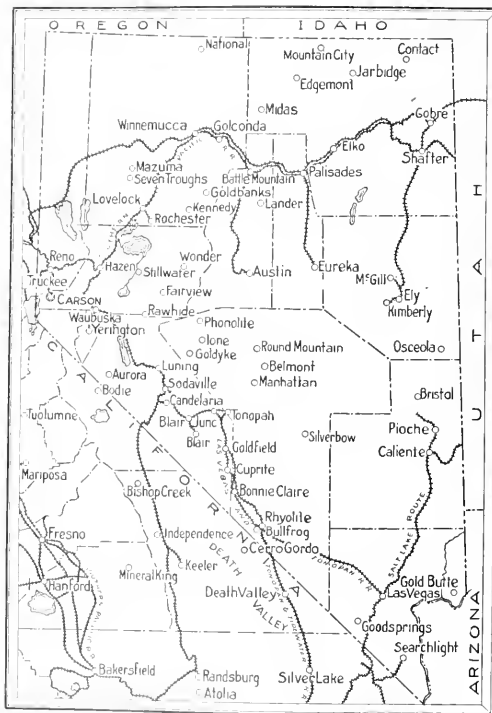
By Al H. Martin

Tonopah has settled down to a fairly steady output of approximately 10,000 tons of ore per week, averaging \$19 per ton. Of this, 7200 tons is from the Belmont, Extension, and Tonopah Mining properties, the remainder from the Jim Butler, West End, Halifax, Rescue-Enla, North Star, and leases on the Montana, MacNamara, and one or two others. The Extension continues to yield the most consistent grade of ore. Sinking of the Victor shaft of the Extension has advanced to a depth of 1720 ft., fair progress being made, although heavy ground was encountered recently. On the 1540-ft. level stoping is going forward on the Murray and North Merger veins, and considerable exploration is being done west of the shaft. On the 1350 and 1410-ft. levels the Murray, North Merger, and O. K. veins continue to develop splendidly. At 1440 ft. the Murray has widened to 6 ft., being the same width as at 1350 ft. On this level the Merger vein is 8 ft. wide, and the O. K. is yielding good ore across a width of 4 ft. From 950 to 1350 ft. extensive work is proceeding on wide faces of milling ore. As soon as the 1850-ft. point is reached cross-cuts will be extended to cut the Murray and other veins to the west. The Belmont company is exploring vigorously with diamond-drills large areas about a mile east of the Belmont mine. This work is being done in virgin ground, and is attracting considerable interest. Net earnings of the company for the first nine months of 1916 amounted to \$929,345, May being the largest month with \$126,263. Work is proceeding on all levels from 600 to 1500 ft. A 4-ft. shoot of promising ore has been opened in the Monarch-Pittsburg, and a 66-ton test shipment made to the West End mill. The discovery was made in raise 1925 from drift No. 1003, and the shoot has been followed for 30 ft. An intermediate west drift has been started at the point of discovery to prospect the formation more thoroughly.

Although reported many times during the past two years there is a strong probability that the Thompson smelter of the Mason Valley Mines Co. will be blown-in within 70 days. Repairs to the plant have been made, and work resumed on a small scale in the mines. It is announced that the 10-ton leaching-plant, operated several months as an experiment, has proved successful and will be enlarged. Sulphuric acid is used as a solvent, and the process is stated to be applicable to either carbonate or well-roasted sulphide ores. Credit for success of the experiments is due G. A. Bragg and E. R. Weidlein. It is understood that the smelter will treat ore from the Bluestone mine, near Yerington, and several small producers in the vicinity of Luning, Mina, Reservation, and other centres, where considerable gold, silver, lead, and copper ore is available. Shipments will also probably be received from the Gray Eagle copper mine, near Happy Camp, California, recently acquired by the Mason Valley company. The mineral holdings of the company consist of 150 acres 1½ miles west of Mason, together with the 1320-acre smelter site and 320 acres of agricultural land. The ore occurs as a contact deposit in limestone and andesite, and has been opened to a depth of 550 ft. Surface ore consists mainly of malachite, but at a depth of 100 ft. massive pyrite containing chalcopirite forms the valuable mineral. The main orebody averages 30 ft. in width, with ore of medium grade.

At Goldfield the exploration of promising territory in the Silver Pick and Jumbo Junior claims considerable interest. The attempt of the Florence Goldfield company to treat profitably its oxidized and low grade gold copper sulphide ore with flotation resulted unfavorably, and the mine and plant have

been closed-down. Sampling of the orebodies proved unreliable, because of constantly varying metal-content, and in many instances the mill-feed was found unprofitable, although sampling indicated the reverse. The company is understood to be contemplating dewatering the 1100-ft. shaft, which is filled with water to the 650-ft. point, with a view to exploration of promising sulphide deposits in the deeper levels. It is also possible that this work may be undertaken from the



MAP OF NEVADA.

deep levels of the adjoining Atlanta mine. Upper workings may be leased. As the company has no facilities for treatment of its oxidized ore, this material will be saved for milling until cyanide equipment can be secured. A large station has been cut just above the 1100-ft. level of the Silver Pick shaft, and a west cross-cut started to intersect the ore-shoots found by the Calyx drill. While sinking a sump, quartz assaying better than at the station was cut, and the shaft will be continued until the alaskite has been penetrated. Seams of ore are exposed, and the excessive faulting of the formation encourages the belief that profitable ore-deposits may be discovered in the alaskite. The Calyx drill is boring a third hole several hundred feet west of the main workings. The new raise from the 880-ft. workings in the Jumbo Junior has intersected fair ore near the Kewanas line, indicating that the vein extends into Kewanas ground. The winze on the vein, near the

Jumbo Extension line, has been discontinued temporarily, and arrangements made to prospect the deposit from the deeper levels of the Jumbo Extension. Driving at this point indicates that the work has been on top of the deposit, and hopes are held for the uncovering of an important body in the shale-lalite contact. The work is going on a short distance north-east of the Velvet claim of the Jumbo Extension.

The C. E. Jury Syndicate, of Toronto, Canada, is preparing to prospect actively the West Comstock district, near Virginia City, recently taken under bond for a reported consideration of \$450,000. The chief engineer, Charles Baycroft, is on the ground arranging for extensive exploration with diamond-drills. It is planned to prospect thoroughly the orebodies to a depth of 1500 ft. The district contains the Bargo, T. & E. Fluck & Mahoney, and other promising mines, and the bond and lease is for two years. The deal was made by W. B. Thomas, long connected with mining in the district, formerly known as the Jumbo field.

Manhattan again shows a disposition to become an important gold producer. Recent work in the White Caps, Big Pine, Big Four, and other mines has been encouraging, particularly in the White Caps. At this property deepening of the 310-ft. shaft to the 435-ft. point is proceeding, and as soon as the objective is gained a series of drifts will be extended to open the shoots disclosed east and west of the 310-ft. workings. Foundations for the roasting-plant are being installed, and the mill will be moved to a site nearer the mine.

Officials of the Salt Lake Route recently inspected the line between Jean and Goodsprings with a view to widening it between these two points by means of a third rail, and extension of the road to supply the mines being developed west of the Columbia Mountain range. Several good properties have been opened in this region, and are in need of transportation facilities. The Akron and Bill Nye properties have been merged into the Goodsprings Bill Nye Mining Co., and arrangements made for an enlarged yield. The Bill Nye has been shipping zinc-lead ore for several months. On the Akron, ore giving high assays in silver and zinc has been opened.

As has been mentioned before, Utah people are to erect a sampling-plant at Jean to handle Goodsprings ore.

Shipments of high-grade copper ore, also containing platinum and gold, are going out from the Boss mine; a recent consignment is reported to have been one of the richest ever shipped. Material and equipment for the new mill are arriving, and the management expects to have the plant in operation about the middle of January. High-grade copper-gold-platinum ore is being shipped from the Oro Amigo, where a deposit assaying 10 to 45% copper was recently opened. On the Milford-Addison, controlled by the Goodsprings Mining Co., a 4 ft. deposit of practically pure sodium chloride was discovered last week. Some of the salt will be used in the new chlorination plant of the Boss company, and shipments made to Los Angeles.

The new camp of Wallace, discovered a month ago by Robert Wallace at a point 12 miles from Winnemucca in the Silver range, is attracting some attention. The Whitaker-Newlands lease has opened a 12-in. shoot at a depth of 35 ft., that is claimed to assay over 800 oz. of silver per ton. On the surface James Truitt and Floyd Harman have opened a 24-in. vein for a length of 200 ft. The ore occurs in contacts of lime-diabase and porphyry-diabase. E. D. Rogers of Sulphur has leased several blocks of promising ground and is building a good camp, preliminary to extensive work. Ore containing free gold and some silver has been uncovered by Albright & Wallace, the shoot being 18 in. wide. A number of new leases have been taken in the past week, and prospecting is becoming active.

The outlook at Rochester is more favorable than for many months, largely the direct result of a more friendly spirit manifested by the leading operators. For over a year some of the foremost companies have been antagonistic toward each other, and this attitude naturally militated against develop-

ment and investment of new capital in the district. Realizing this, some of the operators recently held a conference and agreed to bury their differences. Already a change for the better is apparent. By an agreement entered into by the Rochester Merger and Nenzel Crown Point companies the former is enabled to work its Crown Point Extension claim by way of the Nenzel Crown Point laterals, and the latter company is developing its territory through the Pitt adit of the Merger. The Rochester Mines Co. is increasing its mill and completing a tramway from mine to mill. Excellent ore is showing in the northern end of the Crown Point No. 1 claim, and is being developed by way of the Causten adit. The Nevada Packard has declared its initial dividend, at the rate of 5c. per share, and is credited with an output of \$1000 per day. Good ore is reported by the Rochester United on the south end of the Sunflower claim, leased from the Rochester Merger Co.

Revival of the old centre of Eureka ranks among the most important of late mining developments in Nevada. New capital is opening the properties, many of which have lain idle for decades, and some new mines are in the making. Grossman & Koplan of San Francisco have purchased a two-thirds interest in the Republic from Mrs. May M. Des Marias, and have started work. The mine is on the west slope of Prospect mountain, and has yielded some rich ore. In the Summit, at a point approximately 2000 ft. south of the Diamond mine, a shoot of gold-silver ore has been cut near the surface. Samples assay 150 oz. silver, 50% lead, and \$10 gold per ton. A hoist has been installed on the shaft of the California, and sinking is proceeding rapidly on ore of excellent grade. From the upper workings three carloads of ore are shipped weekly. Hoisting machinery has been placed in position at the Rescue, and the old shaft deepened. Drifts will be extended to seek the veins worked on the main levels. Good ore is coming from the Diamond, Bullwhacker, Marne, and other claims. Silver-lead ore assaying \$65 per ton, with a little gold, is being opened in the Silverado property, controlled by the Summit Queen Co., under the management of Clarence Johnson. The incline shaft of the Connolly has been carried to a depth of 400 ft., and connections made with the new shaft being sunk on the Catlin group. The latter has two compartments, and a manway and will be one of the best equipped in the district.

Eldorado Canyon continues to claim attention, with a determined effort made by the mine-owners to encourage investment of outside capital. San Francisco people are displaying considerable interest, and some of the more promising groups are now controlled by residents of that city. On the Lombard claim, adjoining the Carnation, where rich ore was lately encountered, Charles Herman, M. Fisher, and James German have opened a shoot of high-grade gold-silver ore. Assays are reported to range from \$100 to \$1200 per ton. A compressor and other machinery have been installed at the Eldorado Empire, preparatory to more extensive work. Good ore is showing. The owners of the Enterprise have completed an inspection of the property with the intention of providing additional equipment. The shaft of the Cliff-Era is being rapidly completed to the 200-ft. point, despite the water. From the 200-ft. level a drift will be driven to intersect the orebody that has been traced on the surface for 4000 ft. Isaac Alcock and Frank Hoine have taken a lease on the Lucky Jim and started blocking-out of ore. A new hoist is being installed at the Skylark group, and sinking will be pressed to open fair ore exposed near surface. Several new buildings are under construction, including a hotel. Men are coming in from all parts, and numerous deals are reported to be in course of negotiation. The activity has spread to the neighboring Searchlight district, and several old properties at that point are about to be re-opened and vigorously worked, including the Duplex, Big Casino, and Searchlight. Operations have been increased at the Quartette, which recently passed into the control of New York capital.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

VICTORIA, BRITISH COLUMBIA

ESTIMATED METAL PRODUCTION FOR 1916.—REVIEW OF PROGRESS.

Estimates of the probable value of the mineral production of British Columbia, published recently, give a total of between \$15,000,000 and \$50,000,000. As the year draws to a close it seems as if there is a possibility of the lower total being reached, but little likelihood of the higher one. The provincial mineralogist, W. F. Robertson, issued the following figures as to copper production for the current calendar year: "estimated as probable, 90,000,000 lb. of copper, value \$22,500,000." This would give an increase over the value of the 1915 output of \$12,665,000. The total value of all lode metals other than copper produced in the Province last year was \$10,156,000; that of placer gold and non-metalliferous minerals was \$9,456,000. If the above quoted estimates for copper be realized and there is a 50% increase in all lode metals (which, however, seems to be unlikely for gold and lead), then, as already stated, a total value of \$45,000,000 for this year seems possible, but hardly otherwise; as it does not seem probable that non-metalliferous minerals and placer gold will together considerably exceed their total value last year. Further, the opinion may here be expressed that the quoted estimate for copper is an over-sanguine one.

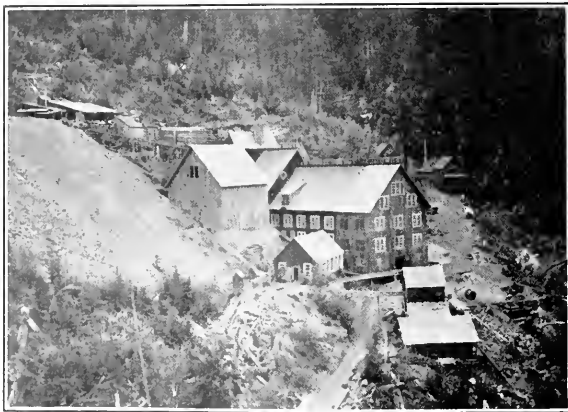
Apart from great expectations relative to total value of production, there are distinctly encouraging features in the mining situation in the Province, for the total dividends paid by mining companies may be expected to be as much for 1916 as for 1915 and 1914 combined. During last year the total was \$1,586,829, and for 1911 \$1,689,331, a total of \$3,276,161. By the middle of November, 1916, total disbursements of companies will be in excess of \$2,900,000, and there will be the customary periodical dividends for the remaining weeks of the year to a total of nearly \$100,000, so that it is reasonable to expect this year's dividends to reach a total of \$3,300,000.

Another evidence of progress is found in the larger number of mining properties that have shipped more or less ore this year. For instance, there are a dozen mines on the East Kootenay list of shippers to Trail, compared with four in the corresponding period of 1915 and that of two in 1911. True, most of these have shipped only small quantities of ore, but the fact that they are producing at all after years of inactivity is regarded with some satisfaction. In degree, other older mining districts are also giving evidence of a revival of interest in mining.

The total of ore receipts at the Consolidated Mining & Smelting Co.'s works at Trail for the 10 expired months of 1916 is 416,551 tons, of which quantity 315,722 tons was from mines operated by the company, and 70,829 tons was of custom ores. By far the greater part of the ore mined by the company came from its mines in Rossland district, and in East Kootenay, the proportions of the several large producers, having been, Centre Star group, Rossland, 1,09,335 tons; Le Roi, Rossland, 104,271 tons; Sullivan, Kimberley, East Kootenay, 76,816 tons. When compared with 1915 and 1914, the 1916 total to November 1 shows a marked increase, as the quantity of ore received dur-

ing the corresponding period of 1915 was approximately 372,000 tons, and in 1914 329,000 tons. The chief increase was made by the Sullivan mine, which shipped 40,700 tons more in 1916 than in this period of last year. Other increases included 6500 tons from the Boundary district (from the company's Emma mine), 3700 tons from Ainsworth mining division of West Kootenay, 2800 tons from the Slocan divisions, a similar increase from United States mines, 1600 tons from Kamloops division of the Yale district, and several minor increases. Partly offsetting these gains was a decrease of about 12,000 tons from Rossland mines, resulting from temporary curtailment of smelting gold-copper ore, owing to shortage of coke for the blast-furnaces.

The Ainsworth mining division of West Kootenay maintains



SLOCAN STAR MILL AND DUMP AT No. 10 ADIT, NEAR SANDON.

its number of ore-shippers to Trail, but two-thirds of the number have only sent small quantities. Of the others, the Bluebell is in the lead for 1916 with total to the end of October of 4069 tons, chiefly of lead concentrate; next comes the Highland with 2645 tons of silver-lead ore, and then the No. 1 with 2381 tons. The Utica has shipped 839 tons; tenders are being invited for driving a deep-level adit at this mine, to open the ore-shoots at about 350 ft. greater depth. The Florence company's total is 834 tons; a considerable output from this property is being prepared, the erection and equipment of a concentrating mill being well advanced. The Comfort, which adjoins the Bluebell group, has shipped 435 tons of lead ore and is expected to continue making an output.

In the Slocan and Slocan City divisions many properties are being worked, including a number that had been idle for years; altogether, 26 are on the Trail list, while two or three others ship zinc ore to the United States. The Standard has this year shipped 3682 tons of silver-lead ore and concentrate to Trail, beside a comparatively large quantity of zinc concentrate to the United States. The Rambler-Cariboo's total is 1598 tons of silver-lead concentrate; its zinc concentrate is now being shipped. The Galena Farm has sent 1367 tons of silver-lead product to Trail, and much zinc concentrate to the

United States. The Slocan Star has shipped 924 tons of silver-lead, and considerable zinc concentrate.

To provide for the cost of re-modeling its concentrating mill, increasing its power-supply, and constructing an aerial tram, some 2300 ft. from mill to railway, the Slocan Star Mines last May raised \$70,000 by the sale of bonds, and later obtained \$10,000 more to complete these improvements. The hydro-electric installation included 9320 ft. of wire-woven wood-pipe, to deliver water under an effective head of 480 ft. to a 51-in. Pelton wheel developing 400 h.p., to operate a 15-drill compressor, and electric generators to furnish auxiliary power. Air for mine purposes is conveyed 2700 ft. in a 6-in. steel pipe. The mill building has been enlarged by a 25-ft. extension, and a 40 by 40-ft. new structure erected to house a flotation tank. The new plant includes a Dorr thickener and Portland filter, while to the mill equipment has been added four Frue vanners, five Deister-Overstrom tables, centrifugal pumps, and a Hardinge 6-ft. conical mill. Additions to concentrating plant have increased the daily capacity from 70 to about 170 tons. Ore-shoots are opened on No. 6, 8, 9, and 10 levels; on the last mentioned the shoot averages between 6 and 7 ft. wide, chiefly of milling ore but with clean galena in parts. Prior to 1906 silver-lead ore to a gross value of \$1,291,728, silver-lead concentrate \$1,229,641, and zinc concentrate \$154,061 (total \$2,675,430) were shipped. Then followed years of extra-lateral right litigation until, several years ago, conflicting interests were merged, and now the outlook is favorable for renewed profitable operation.—Other Slocan mines contributing appreciably to the output of the district are the Hewitt, Idaho-Alamo, Lucky Jim, Lucky Thought, Noonday, Ruth, and Wonderful.

In the Nelson division, the Emerald (lead), Molly Gibson (silver-lead), Eureka (copper), Queen, Granite-Poorman, and Relief (all three gold), and Hudson Bay (zinc) are the chief producers. Work is being resumed on the Silver King (silver-copper) after two years of inactivity. Rossland mines have shipped 269,287 tons of ore to Trail in 10 months of 1916. In Boundary district, the Granby and B. C. Copper companies continue to make a large output and in the last three months the Consolidated company has shipped to Trail 6889 tons of copper ore from its Emma mine. In the Similkameen, the Hedley Gold Mining Co. is the only important metalliferous producer; the Princeton Colliery has lately increased its output of coal. There is gradual improvement in Yale district; the Iron Mask, Kamloops, has shipped to Trail this year about 2700 tons of copper-gold ore. Small shipments are being made from Nicola Valley region; the Highland Valley company has commenced operating a concentrating plant in Ashcroft division. In the lower Coast district, the Britannia company is making a considerable output of copper ore. In the upper Coast district, the Tonopah-Belmont company is erecting a gold-milling plant on Princess Royal island; the Granby company is providing additional power supply to overcome present restrictions. In the Skeena country development is being continued. On Vancouver island the coal mines are making a larger output than that of last year.

BUTTE, MONTANA

BUTTE & SUPERIOR EARNINGS.—TUOLUMNE PROGRESS.—EMMA ZINC.—BUTTE-DETROIT MILL.—ANACONDA ZINC-ORE SCHEDULE.—ELM ORE.

The Butte & Superior dividend for the quarter ended September 30 will be considerably less than recent distributions. The net operating profit was \$947,901, equivalent to \$3.27 per share. The profit for the first quarter was \$3,554,940, and for the next period \$2,062,029. The grade of ore was about the same in the three periods, averaging over 15% zinc and 6 oz. of silver per ton. There was a decrease in the tonnage of ore treated during the third quarter, due to an accident in the shaft that caused a suspension of operations for 11 days.

The cost of mining and milling was \$7.10 per ton, compared with \$6.26 for the second quarter. The average price received for spelter was 8.3c. per pound. Earnings for the quarter ending December 31 will show a considerable increase. The output will be greater, and spelter is realizing a much better price. After disbursements for the dividend of the second quarter, amounting to \$6.25 per share, the company had net quick assets of approximately \$2,700,000. The company now has outstanding 290,197 shares, as 17,500 were recently issued to purchase 35,000 shares of American Zinc, Lead & Smelting Co. The consolidation of the two companies has been much discussed, and it would be of great benefit to the Butte & Superior, as it would provide a selling agency and would result in a much more satisfactory settlement for the silver-content of the ore. The concentrate shipped to the zinc smelter averages over 21 oz. of silver per ton. The silver remains in the retort-residue, and its recovery is expensive. If the companies are consolidated a small plant will no doubt be erected to treat this residue. The offer of one share of Butte & Superior for two of American Zinc as a basis for taking over the balance of the stock was turned down. An appraisal of the American Zinc plants was made recently, and it is probable that a new proposal will be made to trade two shares for three. The hoisting equipment for the new shaft is slow in arriving, and it will not be ready to hoist ore before next April. Meanwhile timber and supplies will be hauled through this shaft with a geared electric hoist.

The Tuolumne has re-timbered the shaft on the Sinbad claim, unwatered the mine and cleaned-up the 500, 600, and 700-ft. levels. A cross-cut will be driven on the 700-ft. level to the south side-line of the property, a distance of 1200 ft. The mine is now in a position to make regular shipments from ore developed in the upper levels. A new hoist is being installed at the Colusa-Leonard shaft, and a new head-frame will be erected. About 60 tons of ore per day is being hoisted through the Tuolumne shaft; this will soon be increased to 100 tons per day. A winze has been sunk on the vein from the 2600 to the 3000-ft. level. Exploration will be done at the 2800 and 3000 ft., and if results are encouraging the shaft will be deepened to facilitate ore extraction.

The Emma mine is shipping zinc ore to the Washoe works. The Emma is in the centre of the residence district of Butte, and it is necessary to haul the ore over the city streets. Six horse-teams are used to haul the ore, and it is not likely that they will be replaced by auto-trucks, as these have a hard time getting up the hills when they are covered with ice and snow. The ore is concentrated at Anaconda and then shipped to the electrolytic plant at Great Falls. The Emma is the property of the Butte Copper Zinc Co., and is being operated by Anaconda under an option agreement. Anaconda has taken an option on the Bonanza, Andy Jackson, and Geneva claims in the south-west part of the district. Shaft-sinking has been started on the Bonanza, and a cross-cut will be driven on the 1000-ft. level to explore for zinc and silver. The claim adjoins the Travona and Ancient claims of W. A. Clark, well-known silver producers in the early days.

The Butte-Detroit Co. has ordered flotation equipment for its 150-ton mill. It was expected that this plant would be operated as a custom zinc mill, but negotiations are under way with the Davis-Daly to supply zinc ore until such time as the Butte-Detroit develops enough ore in the Ophir mine to keep the mill at work. Nothing has been done on the Ophir for more than a month, apparently because of lack of funds. The shaft is 1065 ft. deep; but no development has been done below the 500-ft. level. The Ophir is well situated; it made a good showing as a silver mine, and it warrants development at depth. Davis-Daly has several drifts in ore, from 6 to 10 ft. wide, that averages 50% zinc and 12 oz. silver per ton. Flotation tests on the ore indicate that a 53% zinc concentrate can be made with a recovery of 95%. The low iron-content makes the ore desirable for treatment by flotation.

The Anaconda company is now buying zinc ore for the leaching plant at Great Falls. A tentative schedule has been drawn up for ore containing not less than 10% zinc. The company pays for

- 100% of the zinc-content at 1½c. per pound.
- 80% of the silver-content at market price.
- 80% of the gold-content at market price.
- 70% of the copper-content at 6c. less than market price.

The treatment charge is \$1.50 per ton. The schedule is based on a market price for zinc of 9c. per pound. No doubt shippers will be paid more for zinc when the details of the leaching process are worked out. The treatment charge is low, and there is much silver-zinc ore at Butte that can be mined profitably under this schedule. The old silver mines were forced to shut-down when they opened zinc ore because of the penalty imposed by copper and lead smelters. Now the zinc will pay the cost of mining and smelting, and the money derived from the silver-content is all profit.

The Elm Orlu is mining 500 tons of zinc-silver ore per day. A new electric hoist has been installed, and the shaft has been sunk to the 2200-ft. level. Skip-chutes will be cut on several levels, and when alterations to the mill are completed the output will be doubled. The copper-bearing slime from the old Butte Reduction Works is being put through the flotation department, and this brings the mill-feed up to 800 tons daily. The Clark interests are also opening the Evelyn mine in the Walkerville district. On the 300-ft. level a drift is being driven on a narrow vein of high-grade zinc-silver ore.

LEADVILLE, COLORADO

MONTHLY OUTPUT.—LABOR SITUATION.—MIKADO SHAFT.—EMPIRE ZINC CO.'S MINES.—DOWN TOWN MINES.—JULIA MINING CO.—U. S. S. R. & E. CO.—FRYER HILL.—BEEBE HILL.

The monthly output of the district continues to grow. In October, 80,500 tons of ore of various grades and metal-content was sent to the smelters. The entrance of the Penrose, Cloud City, and Tip Top into the list of producing mines has materially added to the tonnage. These properties will increase their output steadily and several others, notably the Greenback, Mikado, McCormick, and Hilschle will be shipping before many weeks have passed.

Although mine-owners feel concerned over the labor situation, it is generally thought that no trouble will be forthcoming from that source for several months at least. The Union authorities have taken a stand against strikes, stating that more can be secured for the betterment of their cause by open and above-board arbitration with the operators, and unless the radical element gains control of the local branch there appears to be little cause for anxiety for the time being. No change in the situation has occurred. The managers continue to stand pat on their refusal to treat with the Western Federation of Miners. The State Industrial Commission has taken no steps in the matter. The Union men are steadily pushing their organizing campaign, and the crisis that was expected immediately following election has not materialized. The strike that was supposedly pending last month has ceased to be the main topic of conversation, and is only occasionally referred to as a possible happening of the future. The probability of a strike being called at some future date, possibly early in the spring, is now holding up several new concerns that were contemplating entering the district. The continued effort put forth by the Unionists to increase their membership is disquieting to the operators who are now actively engaged and who plan future development. For this reason, the labor agitation has been extremely detrimental to the progress of extensive mining here, and unless a definite decision is reached soon its effects will continue to be felt for some time to come.

George O. Arcall, manager of the Iron Silver Mining Co., is completing an exhaustive scheme of preparatory work at

the Mikado shaft on Iron hill, where he contemplates the extensive development of a large area of rich territory. The shaft has been re-timbered to water-level, a depth of 900 ft. New surface buildings have been erected, including an engine-house, machine-shop, blacksmith-shop, and office. The machine and blacksmith-shops have been thoroughly equipped. A 300-hp. Wellman-Seaver-Morgan hoist has been installed in the engine-room. The hoist is the largest in Colorado. Pumping machinery is expected to arrive during the month; unwatering will be started before the beginning of 1917.

The Empire Zinc Co. is carrying on extensive preparations at its newly acquired holdings, the Robert Emmet and McCormick properties on Yankee hill. The Emmet shaft is being repaired throughout its depth of 900 ft. All the important drifts are being enlarged and re-timbered, and all the underground workings are being put in order for a large tonnage from the immense bodies of high-grade lead, zinc, and silver ores that have been uncovered. The main shoot, which is one of the largest here, continues strong in the deepest workings of the Emmet, and it is planned to sink the shaft early in the coming year. The drainage that has been undertaken through the Wolfstone and Greenback shafts at the instigation of the Empire company has completely drained the Emmet, and it will be possible to add several hundred feet of depth without encountering water. Surface preparations are also being made for efficient handling of the output, which will not reach its maximum next year.—Similar work is being undertaken at the McCormick shaft adjoining the Emmet. The old drifts are being put into shape, and new ones are being driven to cut the orebodies. On the surface, a new railroad switch is under construction to the property, and a new trestle from the shaft to the siding is being erected. These two properties are expected to figure greatly in the output of the district during 1917.

Unwatering of the Greenback shaft, which is being done by the Empire Zinc Co., is progressing steadily. New auxiliary pumping machinery has been installed on the 1100-ft. level. The Layne-Bowler sinking-pump has been connected with the station equipment, and is now lowering the water in the shaft, which is 1250 ft. deep.

The Down Town Mines Co., which has just completed unwatering the large Down Town basin, is now extracting ore steadily through the Penrose shaft. One of the largest bodies of iron-manganese uncovered in the district has been discovered in the Penrose, in ground lying between the old Coronado and Midas shafts. The output is 2000 tons per month. Aside from mining ore, extensive exploration is being done in new territory with a view to opening bodies of carbonate of zinc which are believed to exist throughout this section. The pumps continue to raise 2500 gal. per minute. On the surface, the lack of proper dumping room has necessitated the erection of a long trestle over Orange street to the east of the shaft several hundred feet. The new construction will make available a large space of vacant ground.

The manager of the Julia Mining Co., Clarence Jarbeau, has just completed the driving of a connecting drift from the Cloud City to the Home Extension, a work that was undertaken for the purpose of decreasing the cost of transporting ore. For several months, a large quantity of iron-manganese has been extracted from the Home Extension, where an immense body has been developed. The property is so isolated from railroad service that the ore had to be hauled by team to the nearest siding. The Cloud City, on the other hand, is close to the main line of the Colorado Southern, which runs through the city to the outlying mines, and any ore hoisted through the shaft can be loaded into the cars. The two shafts are less than a quarter of a mile apart, and the orebody lies between them, a fact which has made the driving of the connecting drift doubly advantageous. At present 100 tons daily is being extracted through the Cloud City, and a steady output is still being hoisted through the Home Extension.

The Leadville Unit of the U. S. S. R. & E. Co. is now draining the Jamie Lee shaft on Fryer hill. This shaft is to be sunk 300 ft. as soon as unwatering is completed. The manager, Howard S. Lee, has just made known a decision of the company whereby a good deal of the ground on the upper levels of the Tip Top property is to be blocked and leased. Operations at the Leadville Unit are being followed with keen interest by local mining men, as the developments planned will for the first time reach the formations in the second contact.

In charge of Warren F. Page several diamond-drill holes are being put into Fryer hill from the lower levels of the Progressive shaft. This and surrounding properties have been rich in silver-lead ore, which was found in pockets. No strong and continuous ore-shoot has been uncovered, and the drilling is being done in an effort to find the main vein. No work has been done in this area for a number of years, the revival being due to the draining of the entire section by the Leadville Unit.

The Little Jonny and other properties on Breece hill, controlled by the Ibez Mining Co., are rapidly coming to the front as producers of low-grade copper ore. These rich gold mines of the 90's are now yielding several hundred tons of 6 to 8% copper ore to the district's total, and it is stated that the most recent developments in the Ibez properties indicate a large increase in the copper output.

LEWISTON, MONTANA

DEVELOPMENT IN LITTLE BELT MOUNTAINS.—CYANIDING TAILING.

The high price of metals has stimulated prospecting and development in the eastern part of the Little Belt mountains during the past summer, after many years of quiet. The principal work has been done on the Yankee Girl mine on Running Wolf creek, from which several carloads of lead-silver-zinc ore has been shipped to the Anaconda's new electrolytic zinc plant at Great Falls. The mine was located in 1894, and some rich ore was hauled by wagon to Great Falls, but the lower grade could not pay for such a long haul and little was done with the property until recently. At present 12 to 15 men are employed and several teams are engaged in hauling ore to Stanford, the railroad shipping-point. The orebodies on Running Wolf are replacement deposits in limestone near the contact with porphyry; they have proved to be small and pockety in the past, but an extensive orebody is now thought to have been discovered. Work is being done on adjoining claims, and even if the shoots prove small they will pay to mine and ship at present prices. Paris Gibson and associates of Great Falls have applied for patents on 30 claims containing high-grade hematite, assays giving over 50% iron; the claims are also on Running Wolf creek. Several mines near Barker, Monarch, and Neihart are producing lead and zinc ores regularly, carrying silver and gold. The zinc ore is shipped to Great Falls.

One of the first places to use the cyanide process in the United States was at Giltedge, on the south side of the Judith mountains, in the early 'nineties; the process was not well understood at that time, and the extraction varied from 90% down to practically nothing. As a result, part of the large tailing-pile contains nearly as much gold as when first mined. Turnbull, Caldwell, and Allen are re-working part of this material, said to average \$1.50 per ton, in a small cyanide plant. They have no way of heating solutions in vats, however, so during cold weather operations are suspended.

The Spotted Horse, Maginness, and Cumberland mines at Maiden are being regularly operated by lessees. Since the discovery of the orebody in the Cumberland last spring the lessees have produced \$75,000 in gold, largely in ore shipped to Anaconda. A recent clean-up of the cyanide mill gave \$7000.

Kansas people are to drill for oil and gas near Winifred; the area is favorable for their occurrence.

TORONTO, ONTARIO

OIL PRODUCTION.—COPPER AT PORT ARTHUR.—NICKEL PLANTS.

Much attention is being given to the active and successful development of the Thamesville oil-field in south-western Ontario by the Vacuum Gas & Oil Co., which controls a large acreage and has undertaken operations on an extensive scale. The Thamesville field, which is 50 miles west of London, is not a new oil area, having been about 10 years ago the scene of operations that were considerably more successful in extracting money from the pockets of over-credulous investors than oil from underground. Such actual development as was then undertaken was badly mismanaged, and the field was soon abandoned. It is in the same belt as Petrolia where producing oil-wells have been in operation for 50 years, and the Bothwell pool, which has also a long record as an oil producer, is only $4\frac{1}{2}$ miles distant. The Vacuum Gas & Oil Co., which only commenced active field work five months ago, has already seven producing wells, the most important of which, the No. 1 Featherstone, produces 150 bbl. each 24 hours, with a number of others in various stages of development. Power for pumping is supplied by a gas engine and plant capable of operating 25 wells, which will constitute the first unit. The company having secured control of 800 acres, is planning to add two other units, making a total of 100 operating wells. In addition to its Thamesville holdings the company has 2500 acres in the Brooke oil-pool, and the Kent and Essex County oil-fields, and extensive gas interests. One large gas flow has been secured in the Tillsonburg area, and other gas-wells are being put down. The oil from the Thamesville well is shipped to the Imperial Oil Co.'s refinery at Sarnia. It is high grade, containing 24% benzene and 16% gasoline.

Lately there has been a noteworthy revival of activity in copper mining in the Port Arthur district. The Tip Top mine, 82 miles west of Port Arthur on the Canadian Northern Railway, shipped 340 tons to the smelters last winter. Returns encouraged more energetic development. An extension of the vein was discovered 1000 ft. from the shaft, and another vein was found 26 ft. wide, of which 15 ft. was high-grade ore. This mine has now 20,000 tons on the dump and in the stopes, carrying about 6% copper with small gold and silver-content. A spur-line is being constructed from the mine to connect it with the Canadian Northern, and when this is completed ore will be shipped to the smelters at the rate of 100 tons per day.—The Mine Centre Copper Co. holds under option a claim 3 miles west of Mine Centre on which a discovery was made by Arthur E. Stone last May, comprising a vein 80 ft. in width which has been exposed for 350 ft. The ore has been found to improve in value with depth. Returns from two carloads shipped to the Trail smelter yielded \$1875 gross. Sixty tons per day is being taken out.

The plant of the International Nickel Co., now under construction at Port Colborne, Ontario, will be on a somewhat more extensive scale than originally contemplated, the company having set aside \$5,000,000 for increasing its Canadian equipment. This, however, includes the enlargement of its smelter capacity and an increase in its power. The company is anxious to get the foundations of its Port Colborne refinery completed before the frost sets in, and if this is accomplished expects to be refining nickel within 12 months. The plant will be built in units, so that it can be quadrupled if necessary.—The British-America Nickel Corporation, originally incorporated as the Canadian Nickel Corporation, the refinery of which will probably be in the neighborhood of Welland, will have its smelter near the Murray mine in the Sudbury district, and has already men at work on a power-plant. It now controls 17,000 acres of Sudbury nickel lands, and has obtained the Canadian right to a Norwegian process known as the Hybinette, by which it is claimed that nickel 99% pure can be produced.

ALLEGHANY. A 10-stamp mill is to replace the roller mill at the Twenty-one mine.

AMADOR CITY. Results at a depth of 850 ft. in the Original Amador are officially reported as most satisfactory, the ore being of better grade than on upper levels. Sinking to 1500 ft. is to be started early in December. The mill has been remodeled. By adding an 8 ft. by 22-in. Hardinge ball-mill, and an 8 ft. by 36-in. pebble-mill, these and 20 stamps are crushing 250 tons daily, a gain of 150 tons. The recovery is 90%. The tailing dam has been made 6 ft. higher. A. A. Busey is superintendent.

COLFAX. Reports from the Iowa Hill district state that a large deposit of chrome has been discovered.

HAPPY CAMP. A mill and cyanide-plant are to be erected at the Bradley mine on Independence creek in Siskiyou county. A 12-mile road is being constructed.

JAMESTOWN. The Sierra Nevada Exploration Co., which is operating on Turner's flat, three miles south-west from this place, sinking shafts to open the ancient gravel-channel running along and under Table mountain, is building an electric power-line to connect with the line of the Sierra & San Francisco Power Co. near Montezuma. This is for current to operate the large Neilson pump and electric hoist now being installed. The depth to bedrock where the shaft is being sunk is about 90 feet.

NEVADA CITY. The new 10-stamp mill at the Ocean Star mine, near Washington, was destroyed by fire last week. The property is operated by the Columbia Mines company. The plant is to be re-built. E. C. Klinker is manager.

SMARTSVILLE. The old Blue Point hydraulic mine is to be re-opened by Sidney Wood and others. A water supply has been secured, and gravel can be prevented from going into the river.

COLORADO

DENVER. The entire assets of the United States Reduction & Refining Co., recently sold by the U. S. Court to The Golden Cycle Mining Co., have been purchased from them by the Morse Bros. Machinery & Supply Co. of Denver, who will dismantle the mills. The Standard plant at Colorado City had a daily capacity of 1000 tons embodying chlorination, concentration, and cyanide-plant; crushing was done by rolls and tube-mills. Fifteen hundred horse-power in individual induction-motors drove the machinery. The chlorine gas used in the process was made at the plant. The Union mill at Florence was a 700-ton concentration and chlorination plant, crushing being done by rolls. Electricity generated at the plant with steam supplied current for the motors used there. The U. S. Smelting Co. at Canon City had a smelter making zinc-lead white from zinc-sulphide ores. The plant had a daily capacity of 700 tons. The Bimetallic plant is a modern cyanide-plant of 500-ton capacity for treating tailing from the old Bimetallic mill destroyed by fire several years ago. The dismantling of these plants marks the passing of chlorination treatment of Cripple Creek ores, and is the answer to the controversy waged 10 years ago as to the relative merits of the two processes. The U. S. Reduction & Refining Co. had a capital of \$6,000,000 common, \$4,000,000 preferred, and a bond issue of \$2,650,000. This is the largest purchase of milling plants ever made in the West, and adds quantities of nearly every kind of machinery to the firm's stock. In these plants there is 15,000 tons of machinery, 5000 tons of structural steel and buildings, 2000 tons of pipe, 300 tons of lead, 45 tons of copper wire, 12,000,000 ft. of lumber and 10,000 squares of corrugated iron. Over 1500 acres of land with water-rights was also included.

SILVERTON. Ore shipments during the past week totaled 34 carloads, also 13 to the Silver Lake mill for treatment.

The Pride of the West and Green Mountain mines' mill has been overhauled and is now treating 100 tons daily. Motors and flotation apparatus were installed.

Work is to be continued through the winter at the Champion mine on Sultan mountain, a mile from Silverton.

IDAHO

NINE-MILE. The Alameda Mining Co., which owns and is developing the Alameda mine, control of which recently was acquired by Spokane men, has been awarded \$56,070 by the referee, Lawrence E. Worstell—as the value of the ore alleged to have been extracted from its ground by the Success Mining Co.—who heard the testimony in the case under appointment by Judge Woods of the district court. This award bears interest at the rate of 7% per annum from June 1, 1913, which November 1, 1916, amounted to approximately \$13,410, making the total award with interest, \$69,450. The referee found that on or about April 1, 1912, the Success company commenced to extract ore from Alameda ground, and continued to do so up to August 1, 1914. The trespass, however, according to the report and findings, was committed under an excusable mistake, and the removal of such ore was through inadvertence in the honest belief that it was the property of the Success company. The total amount of the trespass committed on the 400-ft. stope, according to the findings, equals 25,695 cu. ft., and on the 450-ft. level 13,442 cu. ft., while the foot-wall area on the 700-ft. level amounted to 10,323 cu. ft. A ton of ore on the 400 and 450-ft. stopes was found to be equal to 7.49 cu. ft., which assayed 20.45 oz. silver, 20% lead, and 23.95% zinc. On the 700-ft. level it took 8.86 cu. ft. of ore for a ton, and its assay value was 7 oz. silver, 7.5% lead, and 25.7% zinc. The referee adopted the average prices of metals as testified to by Rush J. White as a basis for the value of the ore extracted, which were: 58.78¢. per ounce for silver; 4.236¢. per pound for lead; and 5.188¢. per pound for zinc. It was stipulated during the trial that the mill saving was 56% silver, 72.5% lead, and 65% zinc. The Success contract in force between April 1, 1912, and August 1, 1914, was used by the referee as a basis for computing the freight and treatment charges, and that the reasonable cost of mining and milling the ore was \$2.21 per ton, and that the Success company was entitled to those costs.

The Idaho Supreme Court has reversed the decision of Judge W. W. Woods of the District Court of Shoshone county in the Alameda-Success ore-trespass case, in which it was alleged that the Success company had entered Alameda ground and extracted ore valued at more than \$56,000, according to the findings of the referee, Lawrence E. Worstell. The District Court erred in not making a direct and positive finding as to whether the apex of the Granite vein of the Success company is within exterior boundaries of the claim. The Superior Court concluded that under the evidence the said Granite vein has its apex within the boundaries of the Granite claim. The case will now go to the U. S. Supreme Court.

MICHIGAN

HOUGHTON. Calumet & Hecla reports the following yield for October, in pounds:

Mine	October	10 months
Ahmeek	1,976,977	19,662,663
Allouez	984,126	8,633,609
Calumet & Hecla	6,623,499	63,824,854
Centennial	190,600	2,018,845
Isle Royale	1,035,580	10,261,805
La Salle	121,432	1,075,921
Osceola	1,555,921	16,490,721
Superior	221,162	2,575,692
Tamarack	582,225	5,531,409
White Pine	374,466	3,654,608

The Baltic, Champion, and Trimountain mines of the Copper Range company are maintaining a large output of good ore.

The C. & H. has 21 furnaces in blast at Hubbell. Another furnace is ready to go into commission at Dollar Bay, making

seven at this plant. Good progress is being made at the new foundry.

To increase its output the Osceola company wants more men.

Daily output of the Ahmeek is over 3500 tons of ore, also large quantities of mass copper.

A turbo-generator is to be installed at the Mohawk, to be driven by exhaust steam from the stamps.

MISSOURI

JOPLIN. Cold weather is already curtailing mining and milling operations. Pressure of natural gas is low, and coal may have to be used for a while.

The range for zinc ore last week was between \$85 and \$95 per ton for 60% product, a gain of \$5. The output of the region was 5819 tons of blende, 676 tons of calamine, and 1901 tons of lead, averaging \$86, \$48, and \$85 per ton, respectively. The total value was \$601,952. Miami, Oklahoma, led in production, followed by Webb City-Carterville. The A. W. C. Mining Co. of West Joplin sold 1500 tons of blende on a base price of \$95 per ton.

MONTANA

BUTTE. Cold weather has been interfering with mining operations, ore freezing in bins and cars.

A shaft-house, 70-ft. head-frame, two 125-hp. boilers, hoist, air-compressor, and other equipment are complete at the Great Butte Copper Co.'s mine, two miles north of Meaderville. The shaft has been unwatered and repaired to a depth of 420 ft.; it is 1025 ft. deep.

The new Nordberg hoist for the Davis-Daly has reached the mine. Two cables have also arrived.

From its 2000 and 2200-ft. levels the North Butte is extracting 17% zinc ore. Shipments are to be increased to 300 tons daily. The Anaconda company buys this ore.

To pay for a pump, etc., the Butte-Great Falls company has made an assessment of 5c. a share. A heavy flow of water has been encountered.

One hundred pounds of powder set off at the Bullwhacker mine last week broke over 4000 tons of 5½% copper ore.

The semi-annual meeting of the Montana Section of the A. I. M. E. was held at the Silver Bow Club, Butte, on November 10. This was a postponement of the regular October meeting in order that the members might enjoy the presence of L. D. Ricketts, president of the Institute. Mr. Ricketts spoke for some time on the subject of committee work as applied to technical research. He covered the progress of mining and metallurgy, including possibilities in flotation. B. B. Thayer gave a talk on his recent trip to South America with Mr. Ricketts, Reno Sales, and others. F. G. Cottrell discussed the work of the U. S. Bureau of Mines. He stated it to be the fact that at Anaconda the weight of gaseous products going to waste through the stack was 20 times that of the slag. H. S. Ware, assistant superintendent of the Anaconda smelter, followed with an interesting account of some of the points in connection with the Institute meeting in Arizona. C. W. Goodale and C. R. Kuzell spoke on their recent trip through Arizona. F. E. Marey discussed separation of tailing at small mines. Reno Sales described some conditions in South Africa. C. L. Berrien of the Anaconda compared mining systems, while Frederick Laist mentioned dust losses.

NEVADA

BATTLE MOUNTAIN. The old Dean gold mine has been reopened with J. R. Farrell in charge. A mill is to be built.

EURKA. The Eureka Mining Bureau, composed of local mining and businessmen, are interested in securing syndicates that may be in position to operate meritorious properties requiring some development. The Bureau calls attention to the following groups of claims, which are strongly recommended by local operators having direct knowledge of the conditions: (1) Five claims developed to 350 ft. depth. A 2300 ft.

adit has explored to a depth of 1000 ft. Reserves blocked out are estimated as 75,000 tons of gold-silver-copper ore. Some method of local treatment is necessary. This property can be bonded on reasonable terms for \$75,000, with royalty on shipments of 15%, first payment six months after examination. (2) Thirteen claims on opposite side of mountain to No. 1 group. Two adits driven, one in 2300 ft., the other 800 ft., and one shaft down 400 ft. Thirty shoots are exposed. Shipments aggregate \$600,000. The price is the same as for No. 1 group. (3) The erection of a custom plant is urged as a profitable undertaking to treat the gold-silver ore. At least 50 tons daily could be expected at first, with an increase when the plant started. (4) Electric power is assured if present plans mature. A. G. Hillen is secretary.

GOLDFIELD. A large station has been cut at 100 ft. in the Silver Pick Con. The shaft is in quartz of good quality, in which are seams and masses of gold-copper ore. G. F. Dyer is in charge.

The Hornsilver Milling, Mining & Water Co. has been organized to treat ore at Hornsilver.

RAWHIDE. Reports indicate that in a small though steady way this old place is being actively worked.

ROCHESTER. At a depth of 800 ft., from winze 301, the Rochester Mines Co. is driving in good ore. The October output was about \$55,000. Good progress is being made in enlarging the mill.

White quartz containing ruby silver has been opened in the Nevada Packard mine. The daily output is about \$1200 of silver.

NEW MEXICO

The aerial tram from the Pacific mine to the Socorro M. & M. Co.'s plant, one mile distant, has been completed, tested, and found to operate perfectly. The adoption and placing in commission of this system of transporting the Pacific ore marks the end of an era of operation during which 11,162 tons of ore worth \$171,585 was mined in a crude way, and shipped to local custom mills by burro-train. While the general average of ore mined in the Mogollon district for the same period has been around \$12 per ton, that from the Pacific had an average of \$15.37. With the more adequate mining facilities now employed, in connection with modern tramway delivery to mill, the property may be expected soon to eclipse its past record and take rank with the best producers here. Operations are being conducted by Socorro M. & M. Co. under agreement with the Oaks company.

Mogollon, November 14.

OREGON

SUMPTER. It is said that the old smelter here may be again blown-in by the new owner, J. A. Gyllenberg, to treat ore from eastern Oregon.

TEXAS

(Special Correspondence).—Development of several new cinnabar claims in the Terlingua quicksilver district will be started soon, according to advices received here. It is stated that a syndicate of Houston men, headed by Morris Wexler, has acquired several sections of land in that part of the Big Bend country on which there are outcroppings of cinnabar. It is expected that within a short time all of the mines at and near Terlingua that had lain dormant for the last few years will again be actively worked. While the principal output of quicksilver now comes from the furnaces of the Chisos Mining Co., of which Howard E. Perry, of Chicago, is president, several other companies have resumed development and are extracting considerable quantities of rich ore. The principal mines are those of the Chisos company; the Mariposa Mining Co., of which James Normand of Marfa, Texas, is president; the Texas Abandon Mining Co., of which Henry Hill of Clifton, Arizona, is president; the Study-Butte Mining Co., of which

W. B. Burham is manager; and the Big Bend Mining Company.

Outcrops of cinnabar ore have been discovered east of Terlingua about 60 miles, but so far no steps have been taken toward their exploration. The quicksilver belt also extends across the river into Mexico from Terlingua, and at the time the revolutionary period in that country commenced, several promising claims of cinnabar ore had been filed and were about to be developed.

Terlingua, November 11.

UTAH

ALTA. In the Alta Gladstone mine some of the ore contains from 1 to 8% molybdenite. Development is to be continued through winter, and a mill may be erected in the spring.

The Cardiff Mining Co. paid 25c. per share on December 1, a total of \$125,000. The daily ore output is over 100 tons averaging \$35 per ton.

GOLD HILL. Interest in the Deep Creek district is rapidly increasing, more so as the Western Pacific is constructing a railway into the region. Last week 45 claims in the Clifton section were sold to C. L. Glass of Pittsburg for \$100,000. The four groups contain gold, silver, copper, tungsten, and lead ores.

WASHINGTON

DAISY. The Silver Mountain Mining Co., with a capital of 1,500,000 shares at \$1 each, has been organized by Spokane men to take over and operate the holdings of the Daisy Mining & Milling Co. and the Wakkiagin Mining Co. W. E. Seelye of Spokane, is president and general manager, and Charles H. Goodsell of Spokane, deputy United States mineral surveyor, is consulting engineer. The ore contains silver in small quantities. A mill is proposed. A good deal of development has been done.

CANADA

BRITISH COLUMBIA

GOWGANDA. Good progress is reported in development of this district. Lack of transportation hinders shipments of ore, which is silver-bearing.

NELSON. The Norman Mines Co. of Spokane, has taken a lease and bond on the Madison property, on Reco mountain. The bond is for three years at \$25,000, in installments. Andrew G. Larsen of Spokane is consulting engineer for the company, and he already has a small force at work cleaning out the workings preparatory to an extensive examination. The ore is silver-bearing.

PORCUPINE. During October the Dome mine yielded \$185,000 from 40,200 tons of ore, equal to \$4.60 per ton. The total in nearly three years is \$4,369,371 from 905,482 tons, or \$4.76 per ton.

SILVERTON. A large oil-engine is being installed by the Standard Silver-Lead Company to prevent shut-downs caused by ice in the winter.

MEXICO

A Consular Report states that declared exports of crude oil and petroleum products from the Tampico district to the United States in September, reached a total of 1,900,689 bbl., or some 214,000 bbl. less than in August. Of the total, 1,329,337 bbl. was shipped from Tampico and 571,352 bbl. from Tuxpan. Shipments to points other than the United States are reported as 126,435 bbl. from Tampico and 420,497 bbl. from Tuxpan. Therefore the total oil movement from the Tampico fields during September reached 2,447,621 bbl., compared with the August total of 2,872,939 bbl. As usual, only crude oil was shipped from Tuxpan, and nearly one-third of the total went to Coatzacoalcas, Mexico, for refining purposes. The Tampico movement included \$1,572 bbl. of reduced crude, 83,897 bbl. of fuel oil, 78,500 bbl. of distillate, 19,618 bbl. of gas oil, and 1705 bbl. of kerosene.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

H. W. HARDINGE is at Denver.

E. GYBSON SPILSBURY has been in Cuba.

C. S. HALEY has gone to Volcano, in Amador county.

HOWARD D. SMITH has returned here from New York.

R. GILMAN BROWN has returned to London from Siberia.

A. P. ROGERS has returned to New York from Dutch Guiana.

W. F. FERRIER has returned to Toronto from British Columbia.

C. R. CORNING is expected at New York on his return from South America.

CHARLES W. STIMPSON and E. SHORES, of Salt Lake City, were in San Francisco last week.

F. E. GRAHAM BERRY, of Seattle, passed through San Francisco on his way to Sinaloa, Mexico.

RICHARD A. PARKER spent a few hours in San Francisco on his return to Denver, from Oregon.

W. A. CARLYLE is resident director in Ontario for the British-America Nickel Corporation.

GEO. H. GARREY, who recently returned from Alaska and British Columbia, was in San Francisco this week.

BEN. B. LAWRENCE, who was here early in the week, has been appointed a life trustee of Columbia University.

GEORGE M. COLVOCORESSES, manager for the Consolidated Arizona Smelting Co., was in San Francisco for a few days.

J. H. COLLIER has returned to San Francisco from Cook's Inlet, Alaska, where he is manager of the Gold Bullion mine.

FRED. J. BRULE, formerly with the Anaconda company, has been appointed chief engineer for the British-America Nickel Corporation.

CHARLES T. HUTCHINSON, business manager for the MINING & SCIENTIFIC PRESS, has returned from New York and Chicago, after a highly successful trip.

FOREST B. CALDWELL, formerly at the Candelaria mines, has recovered from a nervous break-down, due to Mexican troubles, and is now residing at Woodland, California.

JAMES F. KEMP has improved in health, but the trustees of Columbia University have granted him a further leave of absence for one year so that his recovery may be completed.

H. H. NICHOLSON has returned to San Francisco from Miami, Arizona, and is now on his way to the Plinco mine, Plumas county, California, after which he will return to Salt Lake City.

JAMES DOUGLAS has presented \$100,000 to the United Engineering Society, the income to be used for the benefit of the library. The Trustees of the Society have perfected plans for the development and the extension of the usefulness of this great engineering library, and are endeavoring to secure endowments aggregating \$1,000,000, the income to be used for the library. The plans of the Trustees had previously been approved by Dr. Douglas. Now that the library of the American Society of Civil Engineers has been added to that of the libraries of the Institutes of mining, mechanical, and electrical engineers in the building of the United Engineering Society at 29 West 39th street, New York, the combined library forms the greatest engineering collection in the world. It is the purpose of the Trustees to extend its usefulness, and it is hoped that the splendid endorsement that Dr. Douglas has given will stimulate other similar endowments until the necessary million dollars has been obtained.

THE METAL MARKET

METAL PRICES

San Francisco, November 28.

Antimony, cents per pound	41
Electrolytic copper, cents per pound	25
Pig lead, cents per pound	7.25-8.50
Platinum: soft and hard metal, per ounce	105-111
Quicksilver, per flask of 75 lb.	\$78
Spelter, cents per pound	13
Tin, cents per pound	45
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, November 28.

Antimony: 50% metal, per unit	\$1.00
Chromite: 40% and over, f.o.b. cars California, per ton	15.00
Magnetite, crude, per ton	8.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO ₃ per unit	15.00

New York, November 22.

Antimony. No business is reported. The last quotation was \$1.50 per unit.

Molybdenite: Supplies are small and the demand is fair, holders asking \$1.85 per pound.

Tungsten. Activity has continued, and since the last report several hundred tons has changed hand at \$17 to \$17.50 per unit. The market is firm at the latter figure, with limited offerings.

EASTERN METAL MARKET

(By wire from New York.)

November 28. First-quarter copper is 35.50c, near-by is quiet, lead is active and independents are advancing; spelter is fairly active.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Nov. 22	Oct. 17
" 23	" 24
" 24	" 31
" 25	" 31
" 26	" 31
" 27	" 31
" 28 Sunday	" 31
" 29	" 31
" 30	" 31

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	11.21	13.60	21.30	July	13.26
Feb.	11.16	14.28	26.62	Aug.	12.51
Mar.	11.11	14.90	26.65	Sep.	12.92
Apr.	11.19	16.61	28.02	Oct.	11.19
May	12.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.17	Dec.	12.75

Bradley produced 1,918,000 lb. in October. Officials of the company are at Miami, Arizona, studying one treatment, as the plant in Chile is to be greatly enlarged.

Columet & Hecla pays \$25 per share on December \$20, this makes \$75 for the current year. Alouette paying \$3 on January 3, and Columet & Arizona \$1 on December 29.

Magma Copper Co.'s profit in the third quarter was \$311,125, from 2,153,264 lb. of metal, nearly the same as in the June period.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Nov. 22	Oct. 17
" 23	" 24
" 24	" 31
" 25	" 31
" 26	" 31
" 27	" 31
" 28 Sunday	" 31
" 29	" 31
" 30	" 31

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	51.28	48.87	47.10	July	47.06
Feb.	51.22	48.44	47.10	Aug.	47.10
Mar.	50.91	49.61	47.10	Sep.	47.10
Apr.	50.72	50.72	47.10	Oct.	47.10
May	50.71	49.87	47.10	Nov.	47.10
June	50.72	49.03	47.10	Dec.	47.10

The silver market is quiet, with prices steady, the result of steady buying.

Topopah companies have raised wages 50c. per shift from December 1, to remain so as long as silver is above 70c. per ounce.

During the week silver worth \$852,000 was shipped from San Francisco to the Orient. Another lot was valued at over \$500,000.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Nov. 22	Oct. 17
" 23	" 24
" 24	" 31
" 25	" 31
" 26	" 31
" 27	" 31
" 28 Sunday	" 31
" 29	" 31
" 30	" 31

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.82	6.23	Aug.	3.86
Mar.	3.94	4.01	6.24	Sep.	3.82
Apr.	3.90	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.68
June	3.90	5.15	6.88	Dec.	3.80

On December 15 the Federal Mining & Smelting Co. distributes \$150,000.

ZINC

Zinc is quoted as spelter, standard, Western brands, New York delivery, in cents per pound.

Date	Average week ending
Nov. 22	Oct. 17
" 23	" 24
" 24	" 31
" 25	" 31
" 26	" 31
" 27	" 31
" 28 Sunday	" 31
" 29	" 31
" 30	" 31

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.39	Aug.	4.75
Mar.	5.12	8.40	18.10	Sep.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.02	16.01	Nov.	5.01
June	4.81	22.20	12.85	Dec.	5.40

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Nov. 22	Nov. 14
" 23	" 21
" 24	" 28

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	39.25	51.90	222.00	July	37.50
Feb.	39.00	60.00	225.00	Aug.	37.50
Mar.	39.00	78.00	219.00	Sep.	37.50
Apr.	38.90	77.50	111.60	Oct.	37.50
May	38.90	75.00	90.00	Nov.	37.50
June	38.60	30.00	71.70	Dec.	37.50

TIN

Prices in New York, in cents per pound.

Date	Average week ending
Nov. 22	Oct. 17
" 23	" 24
" 24	" 31
" 25	" 31
" 26	" 31
" 27	" 31
" 28 Sunday	" 31
" 29	" 31
" 30	" 31

Monthly averages

1914	1915	1916	1914	1915	1916
Jan.	37.85	31.10	41.76	July	31.60
Feb.	39.76	33.23	42.60	Aug.	31.60
Mar.	38.19	48.76	50.50	Sep.	32.10
Apr.	36.10	18.75	51.19	Oct.	30.40
May	32.20	30.18	19.10	Nov.	33.51
June	30.75	19.76	42.07	Dec.	33.60

Tin is steady at 45 cents.

ANTIMONY

The market for antimony has been quiet in New York, although a little activity is noted and quotations to advance about 1c.

Asiatic antimony is quoted at 11 to 14.50c, duty paid.

ALUMINUM

The quotation for No. 1 aluminum, 91 to 99% pure, is 30c. The market is quiet.

Eastern Metal Market

New York, November 22.

Copper prices have touched the highest point in many years, in fact, probably never before have future deliveries been quoted at levels equal to those now prevailing. Last week the market was excited, following a rush to cover requirements over the remainder of the year. Great quantities have been taken for the first and second quarters of 1917.

Zinc is active, largely because of buying by the brass mills. This metal also is selling farther than usual into the future, sales having been made to October. Quotations are higher. Sheet zinc is higher.

The leading lead interest is practically out of the market so far as quotations go. The independents are asking up to 7.25c., New York, for prompt. Prior to the advance from 7c., and thereafter, a good business was done.

The tin market has been unusually active, many hundred tons having changed hands. Quotations are higher, but the advance has been moderate.

Antimony is stronger following a short flurry of buying.

Aluminum is unchanged.

Definite information is at hand regarding iron ore prices in 1917. Sales have been made at Pittsburg at an advance of \$1.30 per ton over this year's price, putting old-range Bessemer at \$5.75 per ton, lower Lake port, and Mesabi Bessemer at \$5.50. The non-Bessemer prices are \$5 for old-range and \$4.85 for Mesabi. Bessemer ores have been in unusually heavy demand. Various increased costs make it clear to pig-iron producers that it will cost them at least \$5 more per ton to make pig iron next year. Pig iron has continued active, with buyers especially desirous of covering for next year. Eastern Pennsylvania No. 2 X foundry is quoted at \$26 to \$27, furnace.

COPPER

The market is quiet, but strong. November and December, both Lake and electrolytic, are quoted at 34c., but these positions are scarce, and none too much is available for first-quarter delivery. As matters stand, fractions of a cent seem to count for little in the copper market, and the situation is one which is causing some uneasiness in the trade. No development would be surprising. Prices may go higher, or the market may break sharply without creating wonderment. Last week the market was a runaway, and in the excitement that accompanied the upward movement of prices a large quantity of November and December metal was sought, although sales were restricted by the limited supply. Toward the end of the week 33.50c. was paid for 1916 delivery. First quarter brought 32.50c., and second quarter 31.50c. These prices apply to both Lake and electrolytic, the unusual differentials having been wiped out. Sales for delivery in the first and second quarters of 1917 in the week ended November 18 are estimated at close to 100,000,000 lb. There is still unsatisfied demand. On the 15th, second-quarter electrolytic was sold at prices ranging from 31 to 32c. On the 20th, December alone, also first quarter, was offered at 34c., and sales of second quarter were made at 32.50c., but the latter is now easier around 31.50c. It is reported, but unconfirmed, that prompt Lake has sold at 35c. The suggestion has been made, and a good portion of the trade is considering it seriously, that copper bought for export at comparatively low prices may be thrown on the market if present market levels hold. The great British purchase was made at 25.50c., according to recent information; and the possibility is pointed out of some of this, or similar metal, being sold at a handsome profit, the sellers then replacing what they had sold. The suggestion may be an outcrop of the nervous strain under which the sellers of

copper are laboring. They do not regard present levels as healthy, and ever recurrent in their minds is the thought of what will happen when support is taken away from the market. The base price of sheet copper has been advanced to 41c., mill. The mid-monthly European statistics give the total supply in Great Britain and France, November 15, at 4792 tons, against 5620 tons, October 15. Including that afloat from Chile and Australia, the available supply for those countries, November 15, was 9617 tons against 10,670 tons, October 15. The London market is gaining strength, the quotation for spot electrolytic yesterday being £163, against £152 a week previous. Exports this month are not heavy, amounting to only 13,210 tons from November 1 to 22; but this does not take into account the enormous quantity going abroad in manufactured form. Reverting again to the domestic market, indications point to quieter conditions in the next few weeks.

ZINC

The brass mills have been generous buyers in the past few days, and business has not been checked by steadily advancing prices. Prime Western for prompt delivery was quoted yesterday around 12.50c., New York, and 12.25c., St. Louis, with December delivery at about the same level, first quarter at 12c., St. Louis, and second quarter at 11.50, St. Louis. Consumers are buying farther ahead than has been their habit, and some good-sized orders are booked for the second quarter, with some business to run as far ahead as October. The premium for brass-mill special, over the price of prime Western is near 1½c., this including delivery. Buying of spelter has admittedly not been in proportion to that for copper, assuming that most of the copper is going into brass, a fact which has not yet been explained. Exports continue heavy, those of the month, up to the 22nd totaling 10,587 tons. The spot quotation at London yesterday was £56 10s., or 10s. higher than a week previous. Sheet zinc has been advanced 1c., to 19c., f.o.b., mill, carload lots, 8½ off for cash.

LEAD

A good demand for lead developed this week, following a prolonged period of quiet, during all of which, however, prices held firm. The independents began to stiffen their quotations late last week, and sales of prompt metal were made at 7.05 to 7.10c., New York. Last Monday (the 20th) independents were asking 7.10c., New York, and yesterday, 7.15c., New York. Up to that time the A. S. & R. Co. was quoting 7c., New York, and 6.92½c., St. Louis, but it is generally understood that the company was not selling at those figures. Yesterday it quoted 7.15c., New York, but today no quotations were obtainable. The outside market today is 7.25c., New York, but business is not so active at this level. The spot quotation at London yesterday was £30 10s.,—unchanged when compared with a week previous.

TIN

In the past 10 days a heavy business has been done in tin, in fact, the activity was exceptional. On various days sales aggregated from 200 to 500 tons. Prices advanced under the demand, but only to a moderate extent, the spot quotation for Straits yesterday being 45.12½c. A peculiarity of the market has been that it appeared quiet at most times, even when negotiations for large quantities were under way. The tin-plate mills have bought heavily for their 1917 requirements. The British continue reluctant to issue licenses to ship, and the resultant uncertainty has undoubtedly made consumers see the wisdom of covering their future needs. Up to yesterday only 1275 tons had arrived, and there was afloat 3852. Most of the recent activity has been in future deliveries.

Industrial Notes

Information supplied by the manufacturers.

The Motor-Truck for Mines

The A. A. Haskins Dolomite Company of San Francisco, which owns a large mine of dolomite, containing at least 3,000,000 tons, is using a motor-truck and a 5-ton trailer to haul 40 tons of dolomite every 24 hours from the mine to the nearest railroad siding, a distance of 10½ miles. Exhaustive experiments made by this company prove that the truck and trailer affords a practical outfit enabling the mine-owner to transport this quantity of mineral at a low cost.

Mills making steel by the open-hearth process use dolomite as a flux. It is also calcined to make lime and plaster. The gas, a by-product, is used for charging soda water and other carbonated drinks. The residue after being hydrated makes a durable lime for making plaster ornaments and stucco work; it is used also as a bleach in the manufacture of paper.

and trailer is \$28.71, while with horses and wagons the same tonnage incurred an expense of \$58.21, resulting in a net daily saving to the owners of \$29.50. The truck paid for itself in the first seven months in service.

There are two shifts of drivers and the truck uses 44 gallons of gasoline and 4 gallons of oil to haul 40 tons, registering a total mileage of 84 miles. In the day time 12 gallons of gasoline is consumed and at night 10 gallons for the round trip. The summer days are extremely hot and the nights cool.

The items of cost are as follows:

44 gallons gasoline at 19c.....	\$ 8.36
4 gallons lubricating oil at 40c.....	1.60
2 drivers, 12 hours each, at \$5.....	10.00
Investment interest	} 8.75
Depreciation	
Repairs	
Employers' liability premium	

\$28.71

The mine is in San Benito county and the truck and trailer are loaded direct from a chute into which the dolomite is



MOTOR-TRUCK AND 5-TON TRAILER HAULING DOLomite.

The road from the mine to the railroad is one of the worst for hauling to be found in any part of the country. It is full of chuck-holes and includes 8 miles of crooked mountain road covered with a fine dust 6 to 8 inches deep. There are steep sharp turns with grades from 8 to 10% and 1½ miles long.

Before purchasing the truck and trailer the company experimented with mules and horses. One animal could deliver to the railroad one ton of dolomite every 24 hours. In order to deliver a minimum amount of 40 tons to fill a freight-car, it was necessary to use five teams of 8 horses each, necessitating five drivers and the regular stable help. The cost of this method was prohibitive and was soon abandoned. A rubber-tired truck was then purchased, but the roads were so rough that the trucks could not operate efficiently.

The company was at a loss to solve the problem of getting the mineral to the railroad until they purchased a White 'Goods Roads' truck and trailer. Now they can satisfactorily meet the market demands, the new equipment being able to make 4 trips in 24 hours from the mine to the railroad and deliver 40 tons of material. The drivers are not permitted to drive the truck over 5 miles an hour, tonnage and dependability being more essential than speed.

The cost of delivering 40 tons of dolomite with the truck

dropped. Three minutes is required for this operation. To reach the chute there is a grade of 10% with 12 inches of dust covering the road. The truck pulls the trailer up this grade and a sharp turn with a 40% curve is negotiated in order to get under the chute. A steep drop from the chute necessitates low gear-work to get onto the road. There are no brakes on the trailer and thus the responsibility of holding the 10-ton load on any part of the grades between the mine and the railroad falls on the truck. A short distance from the railroad the road leads for a quarter of a mile across the deep sand and gravel bed of a river, which is always dry in the summer. The road bed was packed with straw to give better traction.

'Pine Flotation Oils' is the title of a pamphlet issued by the PENNSACOA TAR & TURPENTINE Co. of Florida. A flow-sheet is given of the destructive distillation plant, including a concrete retort, used by this firm. This shows the different points at which the various grades come off. The dead wood of the resinous pine is used. This yields 1000 lb. of oil per cord, or say two tons of wood. The retort holds 11 steel cars of one-cord capacity each. These are left in the retort during the process, and afterward are withdrawn containing the resulting charcoal. A list of oils and prices is also given.

EDITORIAL

T. A. RICKARD, Editor

DELIVERY, not sale, of metal is what counts in the present abnormal condition of the market. Our New York correspondent discusses the point in this issue.

FROM the report of the Consolidated Gold Fields of South Africa, which holds a large interest in the Yuba Consolidated Goldfields, we note that the latter company extracted \$2,133,528 in the year ending February 29, 1916. This yield was at the rate of 12.02 cents per cubic yard. The cost was 4.27 cents, so that the profit was 7.75c. per cubic yard. For the five months ended on July 31, the yield was 12.87, the cost 3.7, and the profit 9.17 cents per cubic yard. This is handsome dredging.

AN employer, a senior engineer, or the chief in a department ought to be willing to aid a younger and less-known man without exacting the honor of joint authorship. We see articles published occasionally by two authors, of whom we suspect that the younger has done all the work, while the senior has dotted the i's and crossed the t's, given a little advice, and then arrogated the privilege of halving the credit for the investigation and its presentment. Older and better-known men should be more generous in giving the younger fellows a chance to distinguish themselves without any discount.

HOW the export trade in spelter has grown is indicated by official figures. During the nine months ended on September 30 the total value of shipments was \$42,000,000, as compared with \$21,000,000 in the equivalent period of 1915, and \$3,000,000 two years ago. Of the 275,000,000 pounds included in the shipments this year, 194 million pounds came from domestic ores and 61 millions from foreign ores smelted in this country. The imports of zinc in ore and concentrate amounted to 245 million pounds, as against 73 and 11 millions respectively in the first nine months of the two preceding years.

STEALING a red-hot stove has been considered the last word of larcenous audacity; the theft of gold from a hot retort is not unknown; but these performances are eclipsed by the story told of the removal of half a mile of copper wire from a high-power transmission line through which an electric current of high voltage was passing while the wire was being cut. This can be done, and is often done, by the use of the 'hot-wire' cutter, a shears fixed to the end of an 8-ft. wooden pole and operated by a wire attached to a wooden lever. If copper continues to rise, we may expect to hear of

many thefts like those that used to worry the power companies in Mexico.

COST of producing copper is rising, of course. The management of mines, like domestic economy, suffers in days of excessive prosperity. Wages, supplies, and machinery have risen from 30 to 200%. Of the total cost of mining, 60% is on the pay-roll, and that has risen fully one-third. It is acknowledged that the cost of producing the metal has increased 25 to 30% at the disseminated-copper mines. Similarly the cost of producing zinc at the Butte & Superior has risen from 4.86 to over 7 cents per pound, an increase of 44%. It will be unpleasant and difficult to revert to the cheaper methods of exploitation when the metal markets relapse.

STOCKS of supplies on the Rand, as at other mines in other parts of the world, have been enlarged on account of the uncertainty of shipping. Thus the value of stores and material held by the mines of the Witwatersrand on July 31, 1916, was £2,600,000, as compared with £700,000 on July 31, 1914—an increase of £1,900,000, or about \$9,500,000. However, the working cost has risen only 16 cents per ton, to \$4.45 per ton, but this, of course, does not include taxation and other expenses omitted in accordance with the pernicious custom obtaining among South African mining companies. The War has caused many of the white employees to serve elsewhere, but the supply of native labor has improved. Another notable consequence of the War is a loss of 12 cents per ounce in the realizable value of the gold, this being due to the extra cost of freight and insurance.

SUPPOSED indefinite persistence of ore in depth suits the promoter and has been used by him many times to enhance the valuation of mines. When the Shamva orebody was uncovered in Rhodesia the promoters of the company formed to exploit it were never careful to limit their expectations, so that the mine was much overvalued and large blocks of shares were sold to an unsophisticated public. Some people think that that is why mines and public were created. We think otherwise. The basic purpose of mining is to make money out of mines, not out of human gullibility. Now, when the mischief has been done, the directors give their shareholders a report by Mr. G. S. Corstorphine in which that distinguished South African geologist states that "the limits as shown by the present workings give practically its [the orebody's] entire mass." He states that the so-called fault, which suggested the hope of finding another

part of the orebody beyond the dislocation, is only a fracture that demarcates the ore. Several years ago the evidence indicated the gradual constriction of the orebody and the probable diminution of ore in depth, but those in control pooch-pooched the inference. They have to acknowledge it now, after the public has been victimized by the earlier optimistic reports.

WHILE the Mexican Constitutional Congress was convening at Queretaro and Señor Carranza was presenting his Magna Carta to the delegates, Pancho Villa was pursuing Trevino's army out of Chihuahua. The *de facto* Government of Mexico has been stultified by its inability to come to the rescue of Chihuahua when attacked by two or three thousand men. The capture of the principal town in the North proves the smallness of Carranza's military resources and exposes his inability to overcome organized revolt. Washington played its money on the wrong horse. The Mexican position is summarized succinctly by that humorous philosopher *Life*: "Next most welcome to having General Carranza's government agree with ours, with suitable results, would be to have it disagree, with appropriate consequences. What we don't want is to have Mexican matters muddle along any further the way they have been going." In short, watchful waiting is wearisome.

REFORM of the mining law was made the subject of a questionnaire, or referendum, to members of the Mining and Metallurgical Society of America and also to 14 other organizations. Of the latter, only one, the California Metal Producers Association, sent the answers of individual members, while two—the Northwest Mining Association and the Nevada Mine Operators Association—voted as units. The expression of opinion was strongly in favor of an abandonment of 'discovery' as a preliminary to location, and the extra-lateral right was condemned almost unanimously, but a number of other reforms, such as the limitation in the number of claims allowed to a locator and the substitution of money payment in lieu of assessment work, found no general support. We cannot see that the referendum is anything more than a parlor game among a number of pleasant people, most of whose opinions might be anticipated by a detached spectator. A society with a membership of 250, of whom only 123 took part in the referendum, is not in a position to reform the mining laws of the United States—laws that affect so many people whom they do not represent. In short, our friends take themselves too seriously. The profession contains at least 2500 men fit to be members in a professional society such as the Mining and Metallurgical; at present the active part of the society consists of a dozen clever and interesting gentlemen living in New York. They are exponents of the best thought and the highest ideals of our profession, but they have no mandate to speak for the mining profession of the United States, much less the mining population of the country. In scanning the replies to this referendum we find one that would, we think, find wide support

among thoughtful men: "My belief is that the old law has already done practically all the damage that it will ever do, and what damage might follow from leaving the law as it is would not be a circumstance to the confusion that would arise from enacting a new law."

STATE mining may be an academic subject in this country as yet, but it is one that is on the horizon, for State ownership of other kinds of industry has been suggested from time to time. In South Africa the subject is a burning question, on which opinions are being elicited by a commission appointed by the Government. We note that one of the witnesses recently catechized by the South African State Mining Commission is Sir George Albu, a mine operator and financier of recognized ability and sagacity. He was frankly against the idea of the State operating mines on the Rand. "Mining," he said, "is always risky, and under State control there would be a tendency to employ political adherents"—of course, like the State Mineralogist's office, in California, for example. He proceeded to say: "A tendency exists to ignore amortization. Without speculation there would be no mining. Propagandists ignore the difficulties and dangers attendant upon mining." Warning to his subject, Sir George referred to the "absolute rot" that had been said about the mines of the Rand; the world had been hypnotized with extreme statements about inexhaustible riches; the awakening had long since taken place. Finally, he asserted that "few individuals distinct from the general public favor State mining." For this abstract of his testimony we are indebted to the *Financial Times*, London. The "absolute rot" that has been talked concerning the Rand is due to the fact that the local papers at Johannesburg and some others in London are subsidized, directly or indirectly, by the financial houses, and also to the fact that some engineers sell not their professional services only but their souls also to their employers.

Porphyry

In our issue of November 18 Mr. W. N. Thayer made a protest against the use of the term 'porphyries' as applied to a group of low-grade big-scale copper mines. His objection is well taken. Among the mines to which he refers are several, such as the Inspiration, Miami, and Ray, in which the principal ore is chalcocite, not in porphyry, but in schist. Indeed the characteristic that the ore deposits mined by the Utah Copper and Nevada Consolidated companies share with the orebodies in the Inspiration and Miami mines is not a similar lode-rock, or matrix, but the dissemination of small particles of chalcocite. Therefore the term 'disseminated copper' mines is preferable.

To the miner 'porphyry' is a word rich in associations; it is resonant with suggestions of mineral wealth. The prospector and the digger have appropriated the term for their own and widened its meaning despite the protest of the petrographer. The word 'porphyry' is

of Greek origin and means purple. The Romans gave the name *porphyrites lapis*, or purple stone, to the rock that they obtained from their quarries at Djebel Dokhan in Egypt. This was the *porfido rosso antico*, or red antique porphyry, of the Italians. According to Zirkel this original 'porphyry' had a beautiful blood-red ground-mass speckled with small snow-white and rose-red crystals of feldspar, the feldspar being a plagioclase accompanied by needles of black hornblende and small crystals of specular iron. Throughout the rock there ran a network of minute veins of accessory quartz. The ground-mass itself was homogeneous, so that no crystals of quartz or feldspar were distinguishable. Such a rock today would be called a 'porphyrite,' and Pliny indeed speaks of the "*porphyrites in Egypto*." Agricola mentions the fact that the columns in the mosque of St. Sophia at Constantinople are made of this same 'porphyry.' Owing to the appearance of this rock the original significance of the term 'porphyry,' indicating purple color, was transferred to the spotted character due to the presence of noticeable crystals in a dense matrix or ground-mass, causing what we now call 'porphyritic' structure.

It may be interesting to recall the fact, related by Vandam in 'An Englishman in Paris,' that it was intended to cut Napoleon's tomb from the ancient porphyry. Guizot got into trouble over the matter in the following way: Visconti, the architect of the Napoleonic monument at that time being erected at the Invalides, wanted the sarcophagus to be made of red porphyry. Guizot acquiesced. It was found, however, that the old Egyptian quarries were exhausted. Inquiries were then made in the Vosges, in the Pyrenees, and elsewhere, for similar stone, but without success, and the idea was about to be abandoned when it was learned at the Ministry of the Interior that this variety of ornamental stone existed in a quarry on the bank of Lake Onega, in north-western Russia. The quarry, however, belonged to the Crown and could not be worked without the payment of a tax. On becoming acquainted with the purpose of the French engineers that had charge of the affair, the Czar Nicholas remitted this tax, about 6000 francs. Although the French paid for the entire cost of the excavating, cutting, and transport of the stone—over 200,000 francs—yet the report was circulated that "Russia had made France a present of the tomb of Napoleon," much to the annoyance of Guizot and the other French ministers.

In designating rocks of this class the ancients restricted the term 'porphyry' to the red variety, thereby recognizing the etymology of the word. Rocks of the same kind, but of other colors, were, according to Quenstadt, called indiscriminately *marmor*, or marble. To the modern petrographer a 'porphyry' is an igneous rock having a homogeneous groundmass that encloses distinct crystals, such as quartz, feldspar, hornblende, or some other mineral, according to which it becomes a 'quartz porphyry,' a 'feldspar porphyry,' an 'augite porphyry,' a 'hornblende porphyry,' and so on. The groundmass may be micro-crystalline or it may be glassy,

and the rock accordingly may be, for instance, a 'granite porphyry' on the one hand or a 'rhyolite porphyry' on the other. In short, the word 'porphyry' is not the name of a particular rock, but an adjectival noun referring to a particular structure or habit, not to the mineral composition. It is more correct therefore to speak of a 'porphyritic rhyolite' than a 'rhyolite porphyry.' According to the German petrographers, the porphyries having a glassy groundmass belong to the newer eruptives, just as those having a micro-crystalline base are supposed to be of more ancient origin. The propriety of this distinction is questioned by many petrographers in the United States and in England. The term 'porphyrite' was confined by Rosenbusch and other German authorities to the pre-Tertiary plagioclase-hornblende group of porphyries, such as diorite-porphyry.

To the Western miner 'porphyry' means an eruptive rock—whether occurring in sheets, masses, or dikes—that is distinguished from granite by its finer grain, and from limestone, and quartzite, or other metamorphic rocks by its fracture. The 'bird's-eye porphyry' of Leadville, which Emmons labeled 'quartz felsite,' is to the Western prospector a type of rocks of this kind. Ignorant as he may be of scientific nomenclature, the average miner has a clear idea concerning the association of certain rocks with deposits of ore, and the knowledge of that association affords him often a serviceable guide in his work of exploration. The 'porphyry' of Colorado is usually a quartz-andesite, the old name of which was 'dacite,' because it prevails in the old Roman province of Dacia, now Transylvania, when it is not part of Germany or Rumania. In California the term 'greenstone' is used in a similar loose way and is likewise associated with ore deposits, particularly gold-bearing quartz veins. In the foot-hill region 'greenstone' is usually either diabase or diorite; and it is to be noted that the speckled or true porphyritic habit of the porphyries in Colorado is not as marked a characteristic of the greenstones in California. Therefore the term has become a misnomer. Much more so, however, is the description of copper mines in schist as 'porphyries.' We hope that technical men will abstain from such blundering usage.

Free Trade in Knowledge

In this issue we publish an interview that serves to summarize the professional career of a supremely useful and public-spirited citizen. Few men are better known or have made more friends in an honorable way than Edward Payson Mathewson. The reasons for it appear in the interview, for no man can be catechized intelligently for a couple of hours without disclosing the main-springs of his action. To us it seems that the metallurgist so long associated with the successful management of the Anaconda works is particularly the exponent of free trade in knowledge, of the open shop in experience, and of the helping hand to the young men of the profession. All of this argues a generosity of mind that is far more admirable than the giving of money or the

endowment of libraries. In the 14 years spent at Anaconda, Mr. Mathewson gave mental hospitality to thousands of technologists from every civilized country in the world, showing willingness not only to allow properly accredited visitors to see the splendid establishment that he directed, but also to give them hints and suggestions that have proved fruitful in many smelters far from Montana. And he did this without allowing any trespass on the property rights of the company whose representative he was; at times reticence—even secrecy—may be required by the exigencies of business, and he knew when those times had arrived, and also when they expired, but it is remarkable that he was able to reconcile his duty to the company with his hospitality to visitors so that the latter forgot the small withholding in the large enlightenment. Another sagacious Canadian, Mr. James Douglas, the Bryce of mining, long ago exposed the stupidity of secrecy in the arts, and himself adopted the open-handed policy, believing it to be best for all concerned. We note Mr. Mathewson's reference to the fact that when the Guggenheims made their big consolidation of smelters, in 1899, it was the secret plants that were found so inefficient that they were put out of business. And we can say, what he naturally forebore from suggesting, that the establishments conspicuous for willingness to give information are exactly the ones that have prospered exceedingly, both in a technical and in a financial sense. Of course, a metallurgical secret is an absurdity, for operations cannot be conducted on a big scale for any length of time without their rationale becoming known to so many men as to render it impossible to withhold the essential knowledge within the smelter-yard. Any enterprising competitor or persistently curious investigator can ascertain the facts if he has sufficient cause for doing so. Secrecy usually indicates meanness of spirit or a desire to cloak ineptitude. The secrets of technology are sometimes only blunders.

But Anaconda under Mr. Mathewson's régime, as it is likely to be under the charge of his able successor, Mr. Frederick Laist, stands for something even finer; it has been a post-graduate school for young metallurgists. We envy Mr. Mathewson nothing so much as the gratitude and respect that goes out to him from scores of technicians, some of them now distinguished metallurgists, on account of the chances he gave them in the years of their apprenticeship. To be able to afford such training is one of the distinctions of which a big reduction works may well be proud. Anaconda has produced something more valuable than copper, than zinc, even than the precious metals. It has made men and the leaders of men. The interview is rich in hints to the young fellows; not to be afraid to tackle any job that is offered, to train themselves in preparation for an emergency, to make records of technical observations, to write technical articles when the necessary material has been collected, to learn to use the English language effectively, to be not afraid to soil their hands with work, yet not to spend too much of their early days at manual labor, to make the acquaintance of the older men, and to not neglect their social duties.

The Playa Blanca episode was the most crucial in Mr. Mathewson's career. It must please our readers to see how men of real bigness of spirit triumph over disaster and live to present their compliments to those that did them an injustice. Mr. Channing has related how he was dismissed by the Bourbons at the Calumet & Hecla, and how he lived to be asked by that company for his technical advice in later years; Mr. Mathewson tells us how he was 'fired' by the Guggenheims at a time when they practically controlled all the lead smelters of the country. As the smelting of lead ores was his specialty, the dismissal seemed calamitous at the time it happened. Time has proved that he was right and that the Guggenheim directorate was wrong, and it has demonstrated also how a man of real capacity cannot be kept down by anybody. From lead smelting, Mr. Mathewson went to copper smelting, in which he achieved an equal specialization, and now, as if to round his career by attacking fresh problems, he takes charge of a big nickel enterprise. We can readily understand how gratifying it must be to him that he has been selected for work so interesting and so important as the British governmental exploitation of the nickel industry in Canada.

The labor question is one that every wide-eyed man must face. Knowledge of humankind is at least as important as that of the metals. Our readers will appreciate the spirit animating Mr. Mathewson's remarks on the relation of employer to employee. Of course, he has placed his index finger on one of the fundamental weaknesses of the big corporation, namely, the dehumanizing of the administration. You can make machinery automatic—or very nearly so—but the complex play of the human relationship will slip a cog if there is no personal contact between the workman and the manager. How well Mr. Mathewson succeeded not only in his duties as an engineer, but also in his obligations as a free citizen in a civilized community is shown by the demonstration that was made when he left Anaconda on October 16. From the local musical organizations that he had encouraged, to the children for whom he had created playgrounds, from the technical men on his staff whose friendship he had won, to the people of the town whose goodwill he had gained—from all of these he obtained a regretful farewell and an enthusiastic godspeed that must have thrilled him to the very core of his being. It was a demonstration of which not only he and his family, but the profession whom he so worthily represents, may well be proud. Other men have been given gold cups and paintings, but there are sentiments that no organized testimonial can express. "For his welfare work in the Town; for his good work in the County and State; for the many things he has done to make this a pleasanter and better place to live, we owe him a debt of gratitude that we cannot repay, and we assure him his name will always be synonymous with good citizenship in this State." Thus said Mr. Laist in an eloquent speech at a farewell dinner. To have "a name synonymous with good citizenship" that is worth more than much refined copper. Young man that reads this: go thou and do likewise.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Grinding Mills at the Inspiration

The Editor:

Sir—I am pleased to note your prompt correction of the unfortunate error which seemed to reverse the meaning of my statement in regard to the experience of the Inspiration Consolidated Copper Co. in their test-mill work using both the Hardinge and Marcy type of grinding mills. I note also that this 'slip of the types' brought a prompt remonstrance from Mr. Hardinge, indicating that the controversy over the form of these popular simplified grinders still lives.

To those who recall the effective advertising program adopted by the Hardinge Conical Mill Co. immediately after they had sold the Hardinge patent rights for Arizona to the Inspiration company it doubtless was quite a surprise and somewhat of a shock to learn that after extensive experiments with both the Hardinge and Marcy machines, the Inspiration company had finally adopted the latter for the extensive grinding equipment required in their new mill. The Hardinge machine was not condemned; its final trial was simply deferred. Those who are familiar with all the circumstances connected with this decision to use the Marcy machine do not criticize the wisdom of it, but there is little doubt that the course pursued left the impression on the minds of the milling public generally that the Marcy type of ball-mill had won in a fair competition with the Hardinge type of ball-mill, and it was in order to correct, in some measure, this erroneous belief that I referred to the matter in the technical discussion you quoted.

Except for determining the comparative value of the material used in the grinding media, it is manifestly unfair to compare the work of a machine using flint pebbles with one using iron or steel grinding media. Mr. Blickensderfer fell into the error of making such a comparison in his paper entitled 'Comparative Test of the Marathon, Chilean, and Hardinge Mills,' which was read at the Globe session of the A. I. M. E. meeting in Arizona, in which he assumed that the work of a Hardinge mill carrying flint pebbles and lined with pebbles should be as good per unit of power as that of a Marathon mill lined with white iron and carrying steel rods as grinding media.

More experiments, to determine the best form of these various types of grinders, and also to get at the facts in regard to the best material, size, shape, etc., to use as grinding media in them, are probably being made in the

South-west than anywhere else at present. The various companies in this region that are interested in the developments are inclined to co-operate with each other in every way, to the end that the good points of each grinder may become a matter of common knowledge among them. The Inspiration company may be considered as temporarily favoring the Marcy mill, the Miami company the Hardinge, and the Phelps-Dodge company the Marathon; but the prejudices of none of them is fixed. That they are still open to conviction and anxious for the truth is made evident by the money they are putting into the installations noted below.

The present Inspiration mill is completely equipped with Marcy mills and is now handling about 16,000 tons of ore per day. Additional sections are being added to the plant and in one of these sections two 8-ft. by 36-in. Hardinge ball-mills, especially designed to meet the Marcy type in a fair competition, will be installed. I understand that the machines will be placed tandem and the first one of the series will receive exactly the same feed as that fed to the adjacent Marcy machines. Its product will go to a mechanical classifier, which determines, through an overflow arrangement, the final degree of comminution; the second mill in the series will work in closed circuit with this classifier, thereby finishing the work to the standard for the district, namely, 1 to 3% plus 48-mesh. The first mill will carry large balls believed to be best suited for reducing the coarse feed, and the second one will carry smaller balls, which are thought to be the best adapted for the final reduction. By using this combination Mr. Hardinge hopes materially to reduce the power required to grind a unit of ore, and otherwise to make a good showing for his machines. The competition will be direct and fair; opportunity for measuring power, weighing input, etc., will be ideal, and the merits of the competing mills will be clearly brought out.

In a neighboring plant the Miami company has been using for some time a full equipment of 8-ft. Hardinge mills in its fine-grinding department. These were installed as pebble-mills but have since been adapted as much as possible to carry steel balls. The result, however, has not been as good as could be expected with machines especially designed to carry 'balls.' This company is the pioneer in the use of the Hardinge machine in the district and has been very favorably inclined toward this type and believes that its use results in the saving of considerable power. The Miami company now proposes to use 8-ft. by 28-in. specially designed Hardinge ball-mills in groups of three. The run-of-mine

will be reduced in crushers to pass a $\frac{1}{4}$ -in. hole and in this condition will be fed to the first one of the Hardinge mills, which will discharge to classifiers, the overflow of which will be finished material, and the coarser sand will be split at the classifiers into two Hardinge ball-mills carrying somewhat smaller balls and adapted to finish the grinding. The last two mills will work in closed circuit with the classifiers and this arrangement will make it possible for the company, besides getting finer grinding than it formerly obtained, to increase considerably the capacity of each section of the plant.

Thus in the Inspiration mill we shall have direct comparison between the work of real Hardinge ball-mills and the standard type of Marcy mill. At the Miami concentrator we shall have real Hardinge ball-mills arranged in what should be an ideal combination for getting the best results out of them. In both cases the grinders will handle ore from practically the same orebody, having the same degree of crushability, and the results obtained should be important and quite conclusive; and these will be the first conclusive results to be obtained, for the reason that this will be the first time these two types of mills have been operated in a proper and fair competition with each other.

During the late trip of the A. I. M. E. party through the district, both of these companies gave out detailed figures as to the results being obtained in their plants. At the Inspiration mill, it is notable that in grinding from $1\frac{1}{2}$ -in. size to 2.9% plus 48-mesh in fine-grinding Marcy mill-sets (including also the operation of the classifiers and belt-conveyor for the feed to the mills) the power used was 9.86 kw.-hours per ton ground; and when the power required for preparing the feed from run-of-mine to $1\frac{1}{2}$ -in. is included, the total amounts to 10.27 kw.-hr. per ton. At the Miami mill the power used for crushing and grinding was given as 7.86 kw.-hr. per ton; but since Miami does not grind all of its tailing to pass a 48-mesh screen, the mills there have not done as much work. The present tailing of the Miami mill contains 11.5% plus 48-mesh, as compared with 2.9% plus 48 found in the tailing of the Inspiration mill, and this difference may account for the difference in power reported.

I understand that the larger Marathon mills being operated by the Detroit Copper Mining Co. at Morenci, Arizona, and the Burro Mountain Copper Co. at Tyrone, New Mexico, have given excellent results as to output per unit of power, and that they are pleased with them. There has been some little mechanical difficulty that has been overcome. These mills have not been run in competition with ball mill or tube mill grinders using iron grinding media. It is significant to note that the Burro Mountain company is preparing to try 'manganoid' balls in a Marathon mill. I do not think that they expect to increase capacity or conserve power by using balls in stead of rods, but I understand that they are interested in proving whether ball ground product is better prepared for flotation separation than rod-ground product and incidentally the results of this trial will be interest-

ing as bearing on the general subject of what is the best form to use.

The New Cornelia Copper Co. is installing a fine-crushing plant using Symons vertical disc-crushers for reducing from $3\frac{1}{2}$ -in. cube to $\frac{1}{4}$ -in. size in two stages at the rate of 400 tons per hour. This type of machine is capable of crushing from 4 to $\frac{1}{4}$ in. in a single stage, but it is thought that power will be conserved and a more desirable arrangement result from dividing the work between three machines per unit, working in two-stage reduction similar to the Miami plan for the use of the Hardinge mill. The Symons machines were designed especially for the work and should set up a new mile-post in crushing-work of this character.

All of these interesting experiments promise to come to fruition early next year and should add materially to our knowledge of crushing and grinding as practised in metal mining.

El Paso, November 21.

DAVID COLE.

Constructive Aid for the Prospector

The Editor:

Sir—The fact is patent, without referring to statistics, that the prospector finds a more attractive field for his endeavor in Canada and other foreign countries than his old stamping-ground, the United States and Alaska. Since the prospector is the fundamental operator of the mining industry, his important relation should be carefully analyzed and the conditions under which he operates well established. The activity of the prospector in the field is a well known index to the activity of mining and any interference with his freedom of operation is directly reflected in a retardation of the industry.

The Federal government, through its Bureau of Mines, can do nothing more useful than study the reasons for the rapid migration of the prospector to foreign fields and remove the causes of it by recommendations to Congress. Pursuant to a better understanding of this subject, it is well to cite a number of the reasons that are most destructive to the occupation of the prospector in the United States and Alaska, as the prospector sees them.

The inborn patriotism of the American is so strong that it is a hardship for him to leave this country for any economic reason, but when he does go into foreign parts, he feels that his own Government should care for his welfare at least as much as the government of the country to which he goes. His position in this matter is sane. Often the United States, for lack of a system of aid to the prospector, not only loses the result of individual enterprise but also a citizen.

To trace this feeling generally that the Government is not protecting but rather hampering the prospector's efforts, it is necessary to go back to 1906-1907 when the land-fraud cases in the North-West and Alaska forced the President to withdraw thousands of acres of public land and place it in reserve to await more specific classi-

fication before re-opening it for entry. At about the same time the conservation idea was sown broadcast without qualification. Like most reforms, the conservation movement was born in theory and since has been developing to meet more practical demands. The theoretical stage was marked by the grossest economic waste of our natural resources, while the more recent constructive conservation recognizes the necessity for developing and using our natural resources. While this movement in the United States started because of high-handed and dishonest land and timber locators, the Alaskan withdrawals resulted from fraudulent coal locations. To the prospector a speculative element was introduced into the title to his holdings. The capitalist backing the prospector soon withdrew his aid on the ground that the title in fee might not be forthcoming as security for his investment. It remained for the Department of the Interior to dispel this idea of uncertainty. The constructive work of the present Department of the Interior began to be felt through the expediting of titles (by clipping much red tape) and through legislation.

The re-opening of vast areas in the United States and Alaska to entry; the passage of the Alaska Railroad and Coal-Leasing bills, marked the first steps in permitting the development of our natural resources after a period of lethargy during which thousands of prospectors were forced to change their field of operation.

The United States Geological Survey has won the public confidence in matters pertaining to land classification. This is due largely to the fact that most capable geologists are selected to advise in such important business. The classification of the natural resources on the public domain, which responsibility Congress long since called upon the Geological Survey to assume, should be rigorously sustained by the issuance of the corresponding land-titles by the U. S. Land-Office. Inasmuch as the funds available are not sufficient to enable the U. S. Geological Survey to keep pace with the public demand for land classification, Congress should recognize the need for increasing this appropriation to an amount commensurate with the public demands, in order not to further block the development of our natural resources. The prospector is vitally concerned in this matter of land classification, and unless the classification keeps pace with his activities, a delay is introduced that is inimical to his best interests.

Many foreign countries have for some time been extending aid to the prospector, both educational and personal. Therefore, in order to complete any system for the help of the prospector, it will be necessary to establish this personal relationship between the prospector and the Government.

From the successful experience of the Bureau of Mines in educating the coal miner in matters of safety, the inference may be drawn that no less success would be attained in extending personal aid to the prospector, but with a different purpose. This favorable result emphasizes the fact that the most successful government is the one which anticipates the needs of those upon whom it depends for support.

This personal aid from a government to the prospector can be no better illustrated than by recounting an experience on the Queen Charlotte islands, off the coast of British Columbia, in 1908. In the month of February, I landed at Jedway, on Moresby island, amid the excitement of a copper discovery. On the same boat was shipped, by the Government, a portable house for the Mining Recorder, a complete set of record books, etc., a portable prison, a Mining Recorder, and a force of men to build trails, fully equipped and provisioned. While many prospectors went in, there was no confusion; individual rights were clearly defined and protected; and the prospectors had every opportunity to devote their time to prospecting rather than to the building of trails. Shortly after came the technical branch of the Government service to counsel and advise the prospector and to publish authentic reports, which were followed by the capitalist's engineer, and the financial assistance to the prospector who had developed a likely prospect. The mining industry based upon so sound a premise of Federal action is bound to be progressive and flourish to the utmost. This is an excellent investment of public funds, judging from the results. One should not wonder why so many prospectors go to Canada when they know that this vital assistance will be rendered.

During the winter months a course of practical lectures is given for the benefit of the Canadian prospector. From these lectures on field mineralogy, methods of mining and milling, and the interpretation of mining law, the prospector gains a grasp of the larger problems of the industry in which he is engaged. He is also better able to estimate his position with respect to capital when he is about to close a deal for his prospect.

The U. S. Bureau of Mines is naturally adapted and organized to assume these functions of personal aid to the prospector. There is no need more pressing than this constructive program. Congress must fully recognize the responsibility of our Government to control the future of a great industry by creating a sound foundation for further progress. It will not require a big appropriation because the means of accomplishment have been partly provided in the establishment of experiment stations throughout the United States and Alaska. In fact, to expand the activities of the Bureau of Mines so as to include this personal service would be to return more dividends from an investment already made.

Now that the general activity of mining is so much improved over past years, there would seem to be a most favorable opportunity to start this work. For the same reason there also appears a still greater need for directing and conserving the efforts of the prospector.

H. N. LAWRIE.

Portland, Oregon, November 15.

MAGNESIAN LIMESTONE, though not preferred by smelters, has been used successfully as a flux. Long campaigns were carried on at the Deadwood & Delaware smelter, at Deadwood, South Dakota, by Dr. Franklin R. Carpenter, when only magnesian limestone was available as flux.

From Precipitate to Bullion

By R. R. Bryan

One of the disagreeable and unsatisfactory performances in a small cyanide plant, employing zinc-dust as a precipitant and treating gold ore, is the handling of the 'clean-up.' It is aggravating that when the precious metal has been concentrated to the degree represented by a precipitate, that still further concentration and refining to a marketable product should require such unwieldy, laborious, and trying operations. In large plants the handling of quantities minimizes some of the difficulties incidental to small plants, but even then it would seem that there is room for improvement over the present cumbersome smelting methods.

The Tavener lead-smelting method, with modifications, is most used in large plants but it entails a tie-up of values and a re-treatment of products that is prohibitive to the small plant.

The method of refining herein described was developed after several months of experimenting and has proved an improvement over the method formerly in use.

Since the difficulties of refining are greatly reduced when treating higher-grade precipitates, it is of first importance to direct attention to such a regulation of the conditions governing precipitation as will produce the highest grade of precipitate possible without increasing the cost or disturbing other essential factors. The way in which this is accomplished is known generally but an outline of the procedure may help those not so familiar with cyanidation. The conditions favoring the making of the best precipitate for refining are:

(1) A pregnant solution free from suspended matter. A clarifying press or similar means is well worth using and there should be no excuse for suspended matter in solution.

(2) A pregnant solution of maximum value per ton. This will depend on other plant conditions and must be determined for each plant accordingly.

(3) Use of the least amount of zinc dust that will give the required barren solution. This will depend on the conditions and requirements of the plant.

(4) A constant cyanide and alkali strength of the solution precipitated. This can always be obtained by careful watching and regulation of the pregnant solution.

Having obtained the best grade of precipitate that the plant can yield economically, its value may be from \$10 to \$60 per pound in gold, the next step is the acid treatment, by which the value of the precipitate is increased \$50 to \$150 per pound.

A decided difference of opinion exists as to the efficiency of sulphuric acid treatment, especially in the small plant. It is undisputed that it removes a large quantity of zinc at a low cost and with much less trouble and loss than can be obtained by the fire method. It is also true

that it introduces sulphur, which, in the subsequent melting, tends to form matte and produces a product whose treatment is generally more destructive to the graphite pot. Prolonged washing reduces this difficulty to a minimum but does not remove it. The use of acids other than sulphuric seems to be regarded with mistrust, probably on account of the greater danger of putting metal into solution and the greater cost and discomfort.

Whether acid treatment be adopted, or not, the refining operations have one common source of difficulty and that is the use of the graphite crucible. This kind of crucible was used originally for the melting (not refining) of a relatively pure metal. It has come to the refining of precipitate through its use in melting the precious metals resulting from retorting and its use in the mints. The graphite crucible is not adapted to withstand the fluxing of metallic impurities nor the corrosive action of slags high in metallic oxides or of oxidizing agents introduced to remove matte or base metal. This crucible introduces a condition that is essentially reducing whereas the operation of refining requires a condition that is essentially oxidizing. The metallic oxides formed in the pot readily attack the graphite and are reduced to the metallic state, joining the precious metals. Some metallic zinc is volatilized and part of this will burn to oxide before escaping from the pot and again react with the graphite, being reduced again to metallic zinc, all of which corrodes the graphite pot and defeats the object of refining. A furnace of the tilting reverberatory type with basic lining should be well adapted to the refining of precipitate, as it would permit the use of oxidizers and the formation of a basic slag high in metallic oxides.

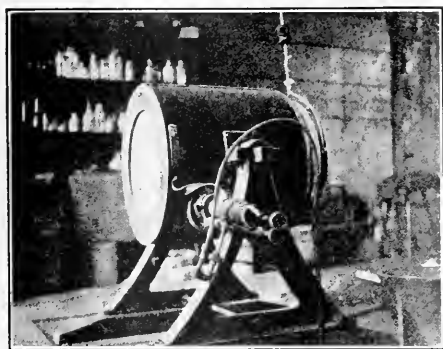
The sulphuric acid treatment was selected because it removed a large quantity of base metal and, in spite of the difficulty introduced by sulphur, made the process more efficient and economical.

The acid-treated precipitate is filtered, washed, and partly dried, enough moisture being left to prevent dusting. Fluxing is as follows:

Precipitate	100 parts
Old assay-slag	75 to 125 "
Iron turnings.....	1 to 6 "

The slag is a good glassy slag high in litharge and borax. The melt proceeds rapidly with only slight boiling and the temperature is held high at the last until the dense yellow fumes have subsided. The pot is then turned down and the slag skimmed to the surface of the matte, with care not to skim so close as to get any matte or metal into the first slag, which is a finished slag. The cover must be turned back for this operation and the pot turned down. At this point the metal is usually about

250 to 300 fine doré. After the first finished slag is removed the surface of the matte is kept clean by raking the scum to the side of the pot as rapidly as it is formed. The rim of contact between the surface of matte or slag and the pot is kept fettled with silex or other silicious material to prevent corrosion. As the charge cools the oxidation is assisted by sprinkling nitre over the surface, raking it to one side as soon as its action ceases and adding fresh nitre. It may become necessary to remove some of this skimmed material from the pot to allow more room. In this case the material removed is kept separate and returned to the pot when turned back for re-heating. Before the metal becomes cool enough to solidify, borax glass, nitre, and silex are stirred into it with a rod until it is pasty. The furnace is then turned back and heated



A TILTING MELTING-FURNACE.

The furnace as illustrated above may be fired by gas or gasoline. It rests on trunnions, and can be tilted through more than 90° by means of a crank, thus discharging the contents of the crucible, and relieving the attendant from exposure to heat. The burner is fastened rigidly to the pipeline, and must be shut-off before the furnace is tilted.

again to a high heat, the slag skimmed off as finished slag, and operation repeated as outlined above. The final destruction of matte will be indicated by the cessation of the dense yellow fumes upon sprinkling with nitre and by the general appearance of the surface. As long as much zinc remains in the metal, oxidation will be slow and the surface will be continually freezing with a scum. The process of oxidation and removal of resulting products followed by stirring-in borax, nitre, and silex is continued until the desired degree of fineness is obtained, as determined by taking a dip-sample and testing with touch-stone and needles. Each cycle of operations will require about 1½ hours and will remove about 40 oz. of base metal in a No. 100 graphite crucible.

The question then arises, to what extent is it profitable to refine bullion for the Mint? Before attempting to answer this, it will be well to consider the table of charges at the Mints and Assay-Offices of the United States. The latest of these schedules went into effect on April 15, 1916. A brief exposition of that part of this

Table of Charges which is of interest to one marketing gold bullion will be given.

- (A) Bullion containing over 800 thousandths base will be declined.
- (B) When bullion is so impure that the loss in weight in melting exceeds 25%, a charge in addition to the regular charge is made.
- (C) Bullion that does not give concordant assays on the first dip may be given an extra charge for re-melting and treatment, and if the second dip fails to give concordant assays the bullion will be refused.
- (D) The regular charges are three in number, as follows:

1. MELTING CHARGE. Equal to \$1 each 1000 oz. or fraction thereof as determined from the weight of bullion after melting.

2. PARTING AND REFINING CHARGE. This is the main item of the charges and depends upon the fineness of the gold and the fineness of the doré. From the following the charges per ounce of weight after melting for parting and refining can be determined for each fineness of gold and doré.

Doré fine	Gold fine				
	1-250	250½-500	500½-949½	950-991½	992-1000
	Charge per ounce weight after melting—				
200-299	\$0.08	\$0.09	...	...	...
300-399	0.07	0.08	...	...	...
400-499	0.06	0.07	...	...	...
500-599	0.05	0.06	\$0.04	...	...
600-699	0.04	0.05	0.04	...	...
700-799	0.03	0.04	0.04	...	...
800-899	0.02	0.03	0.04	...	...
900-969	0.01	0.02	0.04	\$0.04	...
970-1000	0.01	0.02	0.04	0.02	No charge

3. ALLOY CHARGE. Equal to 2.5c. for each ounce of copper required for alloy, as determined by taking one-tenth of the fine weight of gold in the bullion.

From this it will be seen that the parting and refining charge is the only one seriously affected by the refining. Further study of this portion of the charge will reveal some interesting facts relating to the possible reduction in Mint charges by refining. To the mill-man whose bullion will contain some silver but not over one part in four of gold, the study of this table limits itself to the gold fineness ranging from 250.25 to 949.75. Now from 500.25 to 949.75 the rate is a flat 4c. per ounce regardless of the doré, so that refining beyond 500.25 fine gold only results in lessening the Mint charges by 4c. times the ounces of weight lost by the bullion through the removal of base metal. It is quite safe to say that the loss and cost of refining past 500-fine gold for the small plant usually exceeds 4c. per ounce of gross removed, so that from the point of economy the discussion is limited to fineness below 500.25. When fineness drops below 500.25, the rate is dependent upon the doré and the saving effected by refining is not only by a reduction in weight, but also through producing a doré of higher fineness. For this reason, with good manipulation, it is profitable to refine at least to 500.25 fine in gold. As an example, take the following:

	A	B
Weight after melting	500	460
Gold fineness	490	532.6
Silver fineness	95	103.3
Doré fineness	585	635.9
Parting and refining charge per ounce.....	\$ 0.06	\$ 0.04
Parting and refining charge total.....	\$20.00	\$18.40

If the bar *A* were sent to the Mint the parting and refining charges would have been \$30. The bar *B* is obtained by removing 40 oz. of dross; on this the parting and refining charges are only \$18.40, so that the removal of the 40 oz. of dross has decreased the cost of marketing \$11.60 (or 29¢. per ounce of dross), which should be far in excess of the cost and loss in refining this amount. Refining beyond this point only reduces the cost of marketing by 4¢. per ounce of dross removed. When, for the sake of appearance, it seems desirable to produce bars of a greater fineness than 500.25 gold, this may be done and fineness increased to about 800 doré without any considerable increase in the cost and loss of the operation over the saving effected through reduced Mint charges.

Assume a clean-up yielding 100 oz. gold and 25 oz. silver, and assuming that the precious metal loss in smelting is slight, the following table will serve to show the reduction in gross weight and total Mint charges and the reduction in cost of marketing per ounce of base metal removed for each increase of 50 fine doré.

Doré	Gold	Weight, Oz.	Parting and refining		Total cost	—Reduction in—		
			Oz.	Rate		Weight	Cost	Per oz.
200	160	625	\$0.08	\$50.00	\$51.25	...	...	...
250	200	500	0.08	40.00	41.25	125	\$10.00	\$0.08
300	240	417	0.07	29.19	30.14	83	10.81	0.13
350	280	357	0.08	28.56	29.81	60	0.63	0.01
400	320	313	0.07	21.91	23.16	44	6.65	0.15
450	360	278	0.07	19.16	20.71	35	2.45	0.07
500	400	250	0.06	15.00	16.25	28	1.46	0.16
550	440	227	0.06	13.62	14.87	23	1.38	0.06
600	480	208	0.05	10.40	11.65	19	3.22	0.17
650	520	192	0.04	7.68	8.93	16	2.72	0.17
700	560	179	0.04	7.16	8.41	13	0.52	0.04
750	600	167	0.04	6.68	7.93	12	0.48	0.04
800	640	156	0.04	6.24	7.49	11	0.41	0.04
850	680	147	0.04	5.88	7.13	9	0.36	0.04
900	720	139	0.04	5.56	6.81	8	0.32	0.04
950	760	132	0.04	5.28	6.53	7	0.28	0.04
1000	800	125	0.04	5.00	6.25	7	0.28	0.04

It will be noted that in bringing the gold fineness from 210 to 280, which is effected by the removal of 60 oz. of base metal, the cost is only reduced 63¢, or a trifle over 1¢. per ounce of base removed. Let us examine this point more closely. Comparing the charges on this 100 oz. of gold and 25 oz. of silver when in a bar of 250 gold fineness, it will be shown that in the first case the charges would be \$29.25 and in the second \$33.09. Thus, at this particular point the removal of two ounces of base metal has resulted in an increase of Mint charges of \$3.84 or \$1.92 per ounce of base removed. So it seems that this schedule may result in some peculiar charges. At any rate the charges are so moderate that the marketer of bullion should find no cause for complaint although the irregularity may often afford him a chance to save a few dollars by a little refining when the variation is understood.

RAINFALL of Broken Hill, Australia, was 1.13 in. during the half year ended May 31, 1916.

Alloys of Aluminum

Aluminum alloys are receiving more attention because of their usefulness, particularly in aeronautical construction. The copper-aluminum alloy resists atmospheric corrosion well, which appears to be the greatest advantage of adding copper to aluminum. This alloy can be rolled while hot up to a content of 12% copper, though where it is intended to roll the metal 3 or 4% copper is best. For castings, copper to the amount of 10 to 15% may be added to advantage. Nickel acts in much the same way as copper; alloys containing 11 to 12% nickel roll readily when hot, though about 4% is the amount generally added. For castings, 10 to 12% nickel is added. While iron-aluminum alloys possess no particular advantage, aluminum containing up to 2 or 3% iron is not injured by the presence of the iron. It is claimed that the most valuable aluminum alloy thus far made is that produced by the addition of zinc up to 12 or 14%. This alloy possesses about the same ductility as pure aluminum with high tensile strength. Alloy containing 25 to 30% zinc is stronger but is much less ductile. Aluminum-zinc alloys are not suitable for castings. Aluminum-magnesium alloys with the magnesium over 6 to 7% cannot be rolled and shrinkage is least between 3 and 4%. For castings the magnesium content should be between 8 and 12%, if higher the alloy is too brittle. Silicon-aluminum alloy has about the same specific gravity as pure aluminum. The best proportion has been found to be from 5 to 7% silicon for rolled metal and 10 to 12% for castings. With silicon under 8% the alloy suffers less corrosion from water than pure aluminum. Tin-aluminum alloys are valuable and can be rolled cold, but will crack if rolled when hot. These latter alloys resist atmospheric corrosion well, but the elastic properties are seriously affected by the addition of tin. The addition of either lead or bismuth to aluminum has been found to possess no technical advantage. Chromium added to aluminum up to 5 or 6% produces a valuable alloy; one that can be rolled at 500° C. with as much as 4 or 5% chromium, but when the alloy is made with the intention of rolling, not more than 1% should be added, and for casting about 3%. Manganese, up to 5%, can be added and this alloy rolls easily, but the alloy has no advantage over others. Tungsten added to aluminum renders the alloy extremely brittle. Experiments have been made in adding various other elements to aluminum, among them molybdenum, vanadium, titanium, tantalum, and zirconium, but these alloys have been found to possess no particular advantage over the others above mentioned.

COAL consumption in the United States used in heating and cooking is estimated at 1 to 1.5 ton per capita. In 1915 it is stated to have been 1.1 ton. The total consumption of coal for all purposes is about 4.6 tons per capita. The present high and still rising price of coal is charged to the shortage of labor, and of cars for shipment.

E. P. Mathewson, an All-Round Metallurgist

An Interview. By T. A. Rickard

Mr. Mathewson, you are a Canadian?

Yes, I was born at Montreal on October 16, 1864.

Where did you get your early education?

At Montreal, in private schools and the high-school, graduating from McGill University in mining engineering in 1885, as Bachelor of Applied Science.

Was your father connected with mining or metallurgy?

No. He was a wholesale grocer at Montreal, and his father before him.

What made you take to metallurgy?

Intuition, I think. It fascinated me. My first impulse toward metallurgy came when looking at some models of furnaces in the college at McGill. When I entered McGill I did not know what course I was to follow, and went through the first year without making a decision.

What was your first job?

I was a surveyor on the Dominion Geological Survey, surveying lakes in Ontario under Eugene Coste. He was head of the party; A. R. C. Selwyn was head of the Survey at that time; my immediate superior was E. H. Vautelet.

Did you remain with the Survey long?

Just for the summer; then I killed time around my father's establishment during the winter months, and the following spring I decided to go to Colorado. I did not know anyone in Colorado, so I asked my old professor of chemistry, Dr. B. J. Harrington, if he knew of anyone in the West. He referred me to T. Sterry Hunt. Dr. Hunt received me most kindly, at his residence in Montreal, and told me that he knew of one of his former pupils at Yale who was in the smelting business in Colorado, namely, A. W. Geist, and he gave me a letter of introduction to Mr. Geist.

So then you proceeded to Denver?

I met a friend, Tom Drummond, another graduate of McGill, in civil engineering, who was going West to British Columbia. We traveled together as far as Kansas City, where he missed the train, leaving his surveying instruments on board. He wired me to leave them at the Windsor hotel in Denver, which I did. On arrival at Denver, I found there a gentleman by the name of Cushing, who was a Canadian, and who advised me to go to Pueblo as soon as possible, and present my letter

to Mr. Geist, and not be afraid to tackle any job that I might be offered.

That was good advice.

Yes. That's good advice for any young man—always to be prepared to take what is offered, even to the extent of making a small bluff. I took the first train for Pueblo and found Mr. Geist in a receptive mood. It seems that one of his assayers, Ben Sadtler, was leaving him to accept a better position, to take charge of a small furnace at Canyon City, so Mr. Geist told me to report next morning. That was the last day of March 1886. My name went on the payroll of April 1, 1886, but in spite



HOWARD LEAD PRESS AT PERTH AMBOY.

of the date, it has been off the payroll very seldom since. My salary was \$50 per month, 13 hours work on night-shift, and 11 hours on day-shift alternately, in two-week stretches. My partner on the opposite shift was E. N. Engelhardt, now superintendent of the Selby smelter.

The smelter of which you have been speaking was, I take it, that of the Pueblo Smelting & Refining Company.

Yes. A Boston corporation. I remained with that company until March 1897. At the end of nine months I was promoted to the all-day shift, and shortly after was transferred to the laboratory and given over to the tender mercies of the chief chemist, E. C. Engelhardt—no relation to the one previously mentioned. Incidentally, the former is a Russian by birth, and the latter a German. After a few months in the laboratory, owing

to the fact that the chief metallurgist, H. H. Schlapp, left the employ of the company to go to Australia, there was a general move up; Baron de Ropp was made chief metallurgist, my old chum Engelhardt, became his assistant, and shortly afterward the Baron, then 'Tommy' Ropp, left, and Engelhardt became chief metallurgist, and I was promoted to be his assistant. Within a few months de Ropp went to Anaconda to take charge of the lower works there, and sent for Engelhardt to act as his assistant, thereby creating a vacancy, to which I was promoted.

By that time your salary had been increased?

Up to \$150 per month. I made some slight remonstrance with the manager, Foster Nichols, and after some correspondence with the Boston directorate, my salary was increased to \$250 per month, but that included the supervision not only of the lead-silver smelter but the copper department as well, the head of that department, William Foster, having resigned.

What was your copper process?

It was the Crookes process, whereby the matte from the lead blast-furnaces containing a certain amount of copper was desilverized in a series of reverberatory furnaces, in each of which there was a bath of molten lead. After desilverization the matte was given an oxidizing roast, to form what was called 'moss' copper, the name coming from the fact that the metallic copper appeared on the surface of the roasted material in a form resembling moss. This moss copper was then treated in blister-furnaces and the blister put into a refining furnace, to be refined by the old Welsh method.

Can you recall any of the figures of cost in those days?

My recollection is that the cost of producing copper from matte by this process was something like \$40 per ton of matte.

What was the cost of your lead smelting?

In the neighborhood of \$4 per ton of ore.

The smelting was done, I presume, in furnaces of the Piltz type?

No. The furnaces were of the Rachtette type, using coke from Trinidad, mixed occasionally with wood-charcoal. We had water-jackets of cast-iron, and we had two wonderful furnaces, 5 ft. by 8 ft., with water-cooled tuyeres projecting inward six inches on each side. When the ore was free from fine, these furnaces would smelt over 90 tons of charge in a day, which was considered impossible by the fraternity, and doubted by our competitors.

Your ore was mostly from Leadville?

Yes. A little of the copper ore came from Salida. Not much of the ore was treated as strictly copper ore. Some of it came from the San Juan and Clear Creek.

What caused you to move from Pueblo?

In 1897 Ben Guggenheim of M. Guggenheim's Sons, offered me the position of superintendent and metallurgist of the Philadelphia smelter at Pueblo, which had

been built nine years before in conjunction with Ed. Holden, backed by the money of Meyer Guggenheim.

That smelter also was at Pueblo, was it not?

Yes, but I remained there only a short time. I had hardly been appointed when Ben Guggenheim asked me to select my successor, and prepare to go to Perth Amboy to manage their lead and copper refinery at that point. I selected R. D. Rhodes, of Leadville, and we made the necessary arrangements for him to take my place. Three months after my appointment as superintendent of the Philadelphia smelter, I was moved to Perth Amboy.

Did the Philadelphia smelter present any remarkable features?

It was considered a large smelter at that time, and the bedding system—the mixing of the ores in beds—was very carefully done by hand, from tram-ears, so that the charge was fairly uniform on the furnace. They had external crucibles and other fancy stuff when the plant was first started, but these innovations were discarded in favor of standard practice.

You found your new post at Perth Amboy interesting?

Yes. This plant was a large lead and silver refinery, for its day, and had the Möbius method for parting gold and silver. This was an electrolytic method, the silver crystals being deposited either on silver belts or silver plates from a nitric acid solution, while the gold was collected as a mud in canvas bags, the anodes being in the bags themselves. We built some of the largest lead-refining furnaces in existence at that time. They were capable of holding 100 tons of lead at a charge. They have furnaces two or three times as big now, at the same plant.

How long did you remain at Perth Amboy?

I remained there until September of 1897, when I was sent by M. Guggenheim's Sons to Monterrey, Mexico, to succeed the late O. H. Hahn, superintendent and metallurgist of a lead plant there. We treated oxidized ores from the Santa Eulalia, Santa Barbara, Angangueo, and Catoree districts in northern Mexico.

Was your practice remarkable in any way?

One notable feature of the plant was the use of gas-producers for firing the roasters. We made our gas from Coahuila coal, otherwise we would have had to import coal from the United States. The limestone was all hauled from Topo Chico, a distance of a few miles, by ox-cart.

You found it pleasant to be in Mexico?

It was pleasant so far as the climate was concerned, but the labor conditions were peculiar. At that time, on the least sign of rain in the afternoon, the night-shift would fail to show up. We would then send our trusted watchman to scour the town and round up as many Mexicans as he could, and we would put them to work, but every evening we had to count noses to see how many furnaces could be run through the night. Another peculiar feature of the labor at that time was the utter

indifference of the Mexican laborer to the company's interest. If a tap-hole broke out and the hot slag ran over the floor, instead of endeavoring to stop it, the peons would dance around the hot slag like a lot of wild Indians in a sun-dance until the furnace emptied herself.

How long did you remain at Monterrey?

Eight months. I was married in 1890 to Miss Aliee Barry of Montreal and by this time I had a family of two children. My wife and family remained in Montreal while I was in Mexico. I left Monterrey because M. Guggenheim's Sons had secured Mr. Van Cleve as

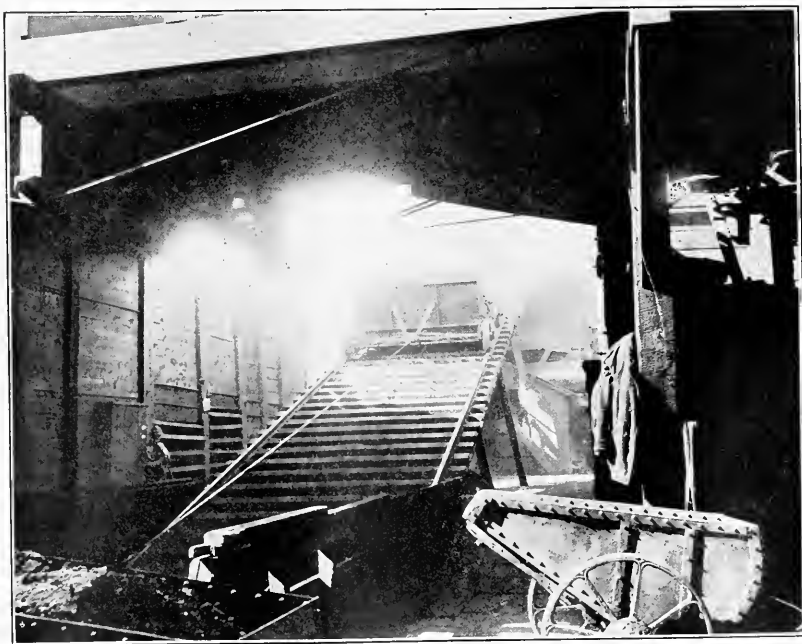
two stands of converters. At Anaconda, at the present time, six stands of converters are treating 1400 tons of matte per day.

Where did you go from Monterrey?

Back to Perth Amboy. Previous to taking charge there again, I made a trip through the West, to Montana, taking in Great Falls, Butte, and Anaconda, then through Colorado back to Perth Amboy, inspecting the various plants on the way.

Do you recall any of your impressions?

The most curious thing that impressed me on that trip



FIRST MECHANICAL FEED FOR LEAD BLAST-FURNACE, PUEBLO SMELTER, 1890.

permanent metallurgist, my position being considered only temporary. Before leaving Monterrey, I paid a visit to Paul Johnson, at Aguas Calientes, where I saw the large converters, the wonders of their day, which were engaged in converting the copper matte made from the Tepezala ore. These converters were 8 ft. across. They had been erected by Hiram W. Hixon. This was before the day of the electric traveling crane, so that the converters all had to be taken out on trucks to be emptied, and had to be taken apart in sections to be re-lined, as is still done at Mt. Lyell, Tasmania. Nowadays converters of this type are 20 ft. in diameter.

Mr. Mathewson, you must be impressed by the greater facilities now afforded to the metallurgist in the handling of his material.

Certainly. At the Mexieau plant, for instance, much less than 50 tons of matte could be treated in a day by

was not metallurgical. I had, a few months previously, bidden farewell to my old friend, August Raht, in Mexico, as he had started for Europe, intending to end his days there. I was surprised in going into the lobby of the McDermott House at Butte, to meet him and find that he was on his way to Australia. I bade him another farewell, and a few months later, I was at Pueblo and looking through the arch in the Union depot, I noticed a familiar back on the platform and went out and found my old friend again, on his return from Australia, heading for New York. Metallurgically, the thing that impressed me most was the size of the Anaconda smelter, which was considered a wonder, even in those early days. The plant, at that time, was handling over 3000 tons of ore daily, under the management of the late John S. Dougherty.

What is the present capacity of the Anaconda?

18,000 tons daily of copper ore, and 2000 tons of zinc ore.

You returned to Perth Amboy?

I returned to Perth Amboy and remained there as manager until September 1899, when the Messrs. Guggenheim asked me to take charge temporarily of a smelter at Playa Blanca, near Antofagasta, Chile, which they had leased from the Huanchaca company, the idea being that I start operations and turn the plant over to my successor in three months. Consequently I left my family at Perth Amboy and reached my destination at Antofagasta on the 13th of October 1899. I immediately put the furnaces in operation, under the charge of Ludwig Klotz, as metallurgist. But in a few months it was evident that I would have to remain longer, so the Guggenheims advised me that they would send my family down to Chile if I would remain a year. This I agreed to do, and my family all came down, with Mr. and Mrs. F. D. Allen, the present agent of the A. S. & R. Co. at Antofagasta, arriving early in 1900. I remained in charge as manager of the Playa Blanca plant until October 13, 1901, when I was recalled to New York.

Did this smelter at Playa Blanca have any interesting features?

It had many. There being no rain in that region, there were no buildings over the furnaces. In places there were sheds to keep off the sun; these were roofed with split bamboo. The furnaces presented a strange appearance. They were all exposed to the open air. The ores were refractory, and fluxes were extremely hard to obtain. The ores came from the Pulacayo mine in Bolivia, 15,000 ft. above sea-level, and were transported in narrow-gauge cars to the smelter, which was near sea-level. The water-jackets of the furnaces were supplied with salt water pumped from the sea. The water for drinking purposes used at the smelter colony was the overflow from a pipe-line, starting near Quilagua, 240 miles long, and this fluid, though clear, was anything but pure. It was contaminated with salt, nitre, borax, etc., and had to be distilled before use. In the town of Antofagasta they used sea-water largely for distilling. The ore, containing copper, lead, and silver, together with a little antimony and tin and considerable sulphur, was made into adobes by hand, mixing it with lime burned on the premises; these adobes were dried by the sun, then piled up in racks and burned with coke breeze, as ordinary mud-bricks are burned. After burning, these were conveyed directly to the blast-furnaces. The amount of impurities in the ore and the lack of fluxes made the slags extremely unsatisfactory to one accustomed to the metallurgy of Colorado, but the capitalists who were backing the enterprise did not see their way clear to advance any money to the poor miners of that country, who had no capital and could not work without some advance in cash. After using up a large quantity of slags rich in lead from Oruro, the discard from the ancient furnaces of the Spaniards, and no other lead being available, an attempt was made to use the

lead concentrates from Broken Hill, Australia, one shipment of these being tried, but there not being sufficient profit in the arrangement, we discontinued their use and substituted concentrate from Moyie, British Columbia.

Which mine?

The St. Eugene mine, in the Kootenay. This, as a business proposition, proved no better than the Broken Hill shipment, and on the advice of Willard S. Morse, representing M. Guggenheim's Sons, we gradually changed the furnaces from the use of lead to copper as a collector of precious metals. To this I objected, on the ground that the copper ores available at Chuquibambilla and vicinity all contained various chlorides, and would result in large losses of precious metals by volatilization. But Mr. Morse saw fit to insist, and the furnaces were changed as directed, with the result that the losses by volatilization proved so great that the operation became unprofitable. Meantime Mr. Morse returned to New York, the Guggenheims having merged with the American Smelting & Refining Co. Shortly afterward I was summoned to New York, and on my arrival there, in consultation with the firm, I advised that the operations of the smelter at Playa Blanca be discontinued, which was done, instructions being sent by cable. At the same time I was fired. This was a serious thing for me, as it appeared to me that all the metallurgical positions in my line as a lead metallurgist were in the hands of one company, and that company had no further use for me.

What did you do?

I took my family to Montreal, and immediately started on a still hunt for a job. I failed to secure one for six months, and was becoming desperate, when a good friend of mine, L. J. W. Jones, suggested that we enter into partnership and start a copper refinery on the Pacific Coast, possibly in British Columbia. I agreed with him that this was a business possibility, as he had a little money and could interest more capital, and I had a little of my own that I was willing to risk. I agreed to start for British Columbia and look into the situation. I had my grip packed, ready to leave, when I received a telegram from Frank Klepetko, asking me if I would come to Anaconda and look into the blast-furnace situation at the new Washoe smelter there, with a view to taking charge of the blast-furnaces if I liked the job.

That was in 1902?

Yes. In June 1902. I proceeded at once to Anaconda, met Mr. Klepetko, who took me down to the blast-furnace room, and this was in such a sad condition that I thought there was plenty of work cut out for me if I liked to take charge of it. I could see no difficulty in the position, so I accepted his offer to act as blast-furnace superintendent. I found a peculiar condition of affairs. No less than eight different men had the authority, and used it, to change the charge of the blast-furnaces as they saw fit, the result being chaos. Of the five furnaces at that time supposed to be in blast, there were never three in operation at one time. I speedily rectified this, to the amusement of the furnace foremen, who found they were

able to keep five furnaces in blast continually. Shortly after this, Mr. Klepetko accepted a position with Mr. Haggin, to go to Cerro de Pasco and build a plant there, and F. I. Cairns was placed in charge of the Washoe smelter, as manager. I was asked to take charge of the



CHUQUICAMATA IN 1899.

reverberatory furnaces and roasters. These reverberatory furnaces were at that time the largest in the world. The hearths were 50 ft. in length and 19 ft. in width, and the furnaces were smelting on an average of 75 to 100 tons per day. These compare with the modern furnace of this type as follows: 140 ft. length of hearth, 25 ft. width, average smelting 650 tons per day.

How do the costs compare?

Costs at present in reverberatory-smelting practice are about one-third of what they were then. A few months later Mr. Cairns resigned to accept a position as manager of the Michigan Smelting Co. at Houghton, Michigan, which position he still holds, and I was placed in charge of the plant, remaining there until this month.

You are leaving Anaconda, Mr. Mathewson?

Yes. I have received a flattering offer from the British America Nickel Corporation to take the position of general manager of their properties in Canada, with headquarters in Toronto. This position I have accepted, and will assume my new duties October 15.

What mines does this company operate?

The company operates the Murray mine near Sudbury, Ontario, and it is proposed to build a smelter near the mine and a refinery for the electrolytic refining of the nickel matte near Niagara Falls, on the Canadian side.

Mr. Mathewson, you have had a good deal to do with the introduction of flotation in America, on a large scale. Could you give me your opinion as to the scope of the process?

So far as my experience goes, the application of the process to sulphide copper ore is a wonderful success,

and can be utilized in nearly every case that has come under my observation. Even where a part of the ore is oxidized, the sulphide portion can be recovered by flotation and a considerable part of the oxidized ore by the original gravity methods of concentration.

What do you think of the new method of sulphidizing the oxidized ore?

From experiments tried at Anaconda, indications are that the oxidized portion of the ore forms such a thin layer on the particles of gangue, that when the sulphidizing is completed and the artificial sulphide mineral submitted to flotation, the gangue floats with the sulphide and no commercial degree of concentration is reached. In my opinion the oxidized ore, or the oxidized portion of sulphide ore is best treated by some form of sulphuric acid leaching.

What episode in your career pleased you most?

My recent appointment in Canada, which came to me wholly unsolicited.

Mr. Mathewson, you know that the technology of metallurgy is under great obligation to you and your staff at Anaconda for your hospitality, not only physically but mentally, extended to properly accredited visitors to your plant. I presume I may take it from you that you do not believe in secrecy in technology any more than our distinguished friend James Douglas.

I am of the opinion that the metallurgist with a secret process is like the ostrich that buries its head in the sand



C. H. MACNUTT, WILLARD S. MORSE, AND MRS. MORSE AT CHUQUICAMATA IN 1901.

on the approach of danger. The metallurgist who is free to give out information is certain to receive information in equal or greater proportion. It has been my experience that on account of the policy pursued at Anaconda I or any member of my staff have been welcomed at the most secretive establishments and shown everything of interest.

Furthermore, is it not a fact that anybody going to work systematically, honorably or dishonorably, as

the case may be, to get at any metallurgical method, can do so?

It is a fact. Secrets cannot be kept in a metallurgical works because so many are employed, and the cupidity of employees is always to be taken into account.

I was informed recently by a metallurgist who used to be at the old Pueblo plant that when the Guggenheim consolidation was made the three smelters that were shut down were the three secret plants, the Kansas City, the Philadelphia, and the Eilers.

There was one other secret one not shut-down, that was the Globe. It is still running, but is not so secretive as it was.

Now that you are leaving Anaconda, I am frank to say that you ought to feel proud of the large number of metallurgists to whom that smelter, under your charge, has been a veritable post-graduate school of metallurgy.

It has always been my idea to give the young technical men under me a chance, and whenever an opportunity was afforded for one of them to better his condition by going to some other plant, I have not hesitated to recommend a man suited for the particular position offered, no matter what place he occupied in our organization. I learned the value of this method in the early days of my experience in Pueblo, with the old Pueblo Smelting & Refining Co., under Mr. Geist. Many of the older metallurgists, some of whom are world-famous, were trained in that establishment, where I received my first knocks.

Who were at the Pueblo smelter?

H. H. Schlapp, of Broken Hill fame; Philip S. Morse, formerly manager of the Cockle Creek smelter in New South Wales; Tommy Ropp, as the Baron was known then; Wayne Darlington, now in Philadelphia; R. C. Canby, of flotation fame; W. W. Adams, now in California; S. D. Bridge, who made his name in Mexico; Ben Sadtler, afterward professor at Golden; O. J. Smith, of Reno, Nevada; and among the later crop, W. H. Howard of Salt Lake, E. H. Hamilton of Trail, B. C., W. J. Hamilton of Cerro de Pasco, Peru, Forest Rutherford of Douglas, Arizona.

Do you regard metallurgy as a good career for the young men of today?

I do.

Do you think that metallurgists or managers of metallurgical establishments should have a financial interest in the company with which they are connected or in other mining or metallurgical enterprises?

I do.

You are doing some interesting work in the electrolytic reduction of zinc. Would you mind saying something about it? Particularly in regard to the future of this new branch of the art.

The work done at Anaconda in the electrolytic reduction of zinc has been most interesting. The general principles involved are the roasting of the ore; the solution of the zinc in sulphuric acid; the purifying of the solu-

tion and then the electrolysis. Each step in the process must be most carefully watched, particularly the purification of the solution before electrolysis. The obtaining of a zinc sulphate solution from the ore is by no means new to the art; but the details of the process in use at this plant have many novel features—just at this time we are endeavoring to protect these by patents—and consequently I am not at liberty to divulge this information. However, I will say that this new branch of the art promises great things for low-grade copper ores and low-grade lead-zinc ores (containing zinc above 12%). By the removal of the greater part of the zinc, the ore becomes readily amenable to treatment. Many mines have large reserves of ore of this character which heretofore have been unworkable and classed as waste; and these reserves will now become available.

Would you agree in the opinion that electrolytic zinc is likely to drive retorted zinc out of the market.

No.

Did you receive the Gold Medal of the Institution of Mining and Metallurgy?

Yes, in 1911, and the receipt of this medal was the source of a great deal of pleasure to me.

Do you believe in young professional men writing technical papers?

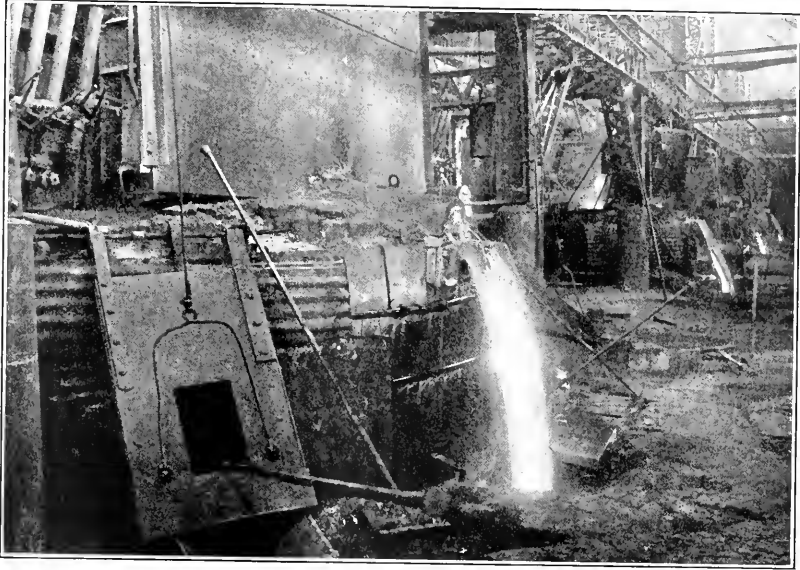
I certainly believe in young professional men writing technical papers and contributing to the technical press, if they have anything to write about. A great many little things come up in practice that it is well to have recorded. It is a good thing for the young men to put their ideas into a crystalline shape and to get into the habit of making notes systematically. I certainly agree with you; and in this connection, I think it would be well for all our mining schools to pay a little more attention to English, so that their graduates will be able to make readable reports and write short technical articles without any great effort. The manner in which facts are presented to a board of directors by the technical men in the employ of a company has a great effect upon the actions of the said board in approving or disapproving the recommendations made.

Do you approve of the present system of settling ore-purchases on the quotations given in a technical journal? Would it be practicable to settle on the price obtained by the smelting-purchaser?

Of two evils, choose the less. I think the settlement on quotations given in a reliable technical journal is the less evil. We want to settle on the true market value of the metals. The only way we can approach that is to get the figures of actual transactions. If the technical journal or its people has no dealings in the market, if it cares for its reputation, the results are not too bad. I do not think it practicable to settle on the price obtained by the smelting-purchaser because no smelting-purchaser would be willing to give out the actual figures pertaining to his sales of metals.

To what extent is the enlargement of copper furnaces likely to go?

The furnaces in most establishments are now as large



TAPPING MATTE FROM THE BLAST-FURNACE AT ANACONDA.



CONVERTER TAPPING-FLOOR, ANACONDA, 1902.

as the ore-supply warrants. There is no limit to the length of a blast-furnace, but under existing conditions there is no advantage in the operation of furnaces over 75 ft. in length. The construction of the building to house very long furnaces is too expensive. In reverberatory-practice the limit of economical size of furnace has not yet been reached but the units are now about as large as it is safe to make them to insure regular output. When the unit in reverberatory-practice is too large, two units being down for repairs at the same time would cause serious reduction of output. On the other hand, in blast-furnace practice, any part of a furnace of the type used at Anaconda may be repaired while the rest of it continues operating normally. I believe that there will be no great enlargement of copper furnaces unless the supply of ore at some given point is enormously increased.

Referring to the saving of labor and the use of electric cranes, can you outline the extent to which such machinery has replaced manual labor?

Without electric cranes the big converter installations of the present day would be impracticable. In repair-shops and power-plants also, modern requirements demand such machinery. The builders of smelting and power machinery today always count on traveling cranes as part of the regular equipment; therefore they have no hesitation in designing parts weighing tons, whereas when only manual labor was used such heavy pieces would be out of the question. A great change has come over the laborer of today. He is accustomed to all kinds of labor-saving devices, and the man who makes his bread by the sweat—literally—of his brow around a smelting-plant is a rare specimen.

In what direction lies the further development of copper metallurgy?

In the saving of values from the flue-dust and smoke, and the similar saving from the oxidized portion of tailing. I believe the time is not far distant when the application of electricity to the copper-smelting industry will be as important as it now is in copper refining. There is room for improvement in the reduction of copper in furnace-slags.

You have had a lot of experience in the abatement of smelter fumes; do you consider that this difficulty has been overcome?

Each smelter-plant has its own particular smoke problem, and it will not be solved until there is a market for all the by-products that can be obtained from smoke. This means the utilization of the sulphur, either as elemental sulphur, as sulphur dioxide, sulphuric acid, or some other compound. In my opinion, if care be taken in the selection of a smelter site, so that the gases be discharged at a considerable height above the surrounding country, and settling apparatus, either electrical or mechanical, be installed to remove dust, no trouble should be experienced and no material damage done. The dilution of the gases with air and their discharge as high as practicable above surrounding lands is the

best way to dispose of them until the time comes when all possible by-products can find a market. The addition of water to spray the gases is inadvisable, in most cases, on account of the liability to pollute streams and water-courses with the product.

You have helped many young professional men. Would you please give some advice based upon your experience in aiding them?

The remarks above referring to the working-man apply to professional men also. I think it is well in dealing with young professional men to caution them not to be afraid to dirty their hands or clothes, but at the same time not to forget that they have spent a number of years of their lives in preparing for a professional career, and to spend many additional years at manual labor is a mistake. Wherever possible it is well to encourage young men not to neglect their social duties. When a friend or business acquaintance has a position to offer that would suit any of your young men, give them a chance at it; get acquainted with your young professional men and if there are too many of them, as in some large establishments, for personal acquaintance with all of them; see to it that your trusted subordinates attend to this matter. I think it a mistake to pay young professional men high salaries at the start, as it gives them wrong notions of their value. Give them enough on which to live decently and then increase their salaries as they merit it.

The management of men, as well as machinery, has engaged your attention. In what direction do you discern the best hope of allaying labor troubles?

The best way to avoid labor troubles is to give the laboring-man a square deal, paying the highest wages that the enterprise can afford. In these days the laborer seldom sees the capitalist who is responsible for his employment. The personal contact of the employer with the employee must be accomplished in some way, and the best way is to have the employer's representative, either the general manager or the superintendent, given full power to treat with the employees in all matters pertaining to wages and working-conditions. The general manager and the superintendent should be selected with a view to their ability to handle men. The old-fashioned swearing foreman armed with a pick-handle has gone, never to return. The modern workman reads the papers, he knows the stock market, and has a pretty shrewd idea as to just what amount of money his employers are making out of his labor and whether or no he is receiving his fair share of the profits. I believe a system of bonuses should be established wherever possible, by which the faithful employee should receive in prosperous times a fair percentage of the abnormal profits accruing to the business. Laboring-men should be encouraged to save their money, marry, and settle down in homes of their own. Amusements should be provided, but not in the form of donations. A man seldom appreciates anything acquired without an effort on his part. Anything that can be done to make a man love his work is a boon to the man and to his employer.

Manufacture of Chromates From Chromite

By Harold French

In the preparation of chromates and bichromates of sodium or potassium, high-grade chromic iron ore is essential. Ores containing less than 50% chromium sesquioxide (Cr_2O_3) however suitable for the manufacture of ferrochrome and chrome bricks, are not desired by the industrial chemist. As there is a rapidly increasing demand for chromite averaging between 50 and 55% Cr_2O_3 and low in alumina content, it will save time, money, and worry if the producers will sort the high-grade ores according to the requirements of the manufacturers of these refined salts. Although chromic iron is mined or occurs in 26 of the counties of California, and a number of these deposits contain considerable bodies of high-grade ore, there is much complaint from the purchasers that the ores are not properly sorted, so that the general average of shipments is too low for economic treatment. Alumina is a particularly objectionable constituent in chromate manufacture, although it may be highly desirable at chrome-brick plants. A better understanding of the processes described below may lead to more discrimination on the part of the producer in segregating the various grades he desires to market.

Inasmuch as the price of potassium bichromate has risen during the past two years from 5 to 40c. per lb., f.o.b. New York, domestic users of this salt have undertaken to manufacture chromium compounds for their own needs. Tanneries consume a large part of the supply of chromates and chrome alum in producing a quality of leather that will resist heat and acids. In California, the Sawyer Tanning Co. of Napa, requiring about 600 lb. of bichromate daily, decided to manufacture its own salts from Californian ores. Since the sodium salt is ten times more soluble than the potassium and much cheaper to prepare, they have established a large chemical plant at their works. While the process they are working is not a complete technical success, it serves its purpose and is a source of considerable saving. Its full efficiency depends upon a reliable supply of high-grade chromite ore.

In a large structure, roofed with corrugated iron and floored with cement, the highly soluble normal chromate of soda is now being manufactured. On the outside are sorted piles of chromic iron that have been shipped from Amador county and from the near-by Chiles and Pope valleys in Napa county. At a glance the character of three standard grades may be estimated. The best quality is fine-grained and brittle, resembling anthracite coal. This contains from 50 to 55% chromic oxide and gives the best results. A middling grade has the appearance of dull graphite, characteristic of most chromite ore mined in California, and averages 44%. A third lot,

supposed to be high-grade chromite, assays only 35% and has a rusty ochreous color; it is useless for manufacturing purposes, and the producers of it may look elsewhere for marketing their product.

After crushing dry to a fine powder, the pulp is fed into reverberatory furnaces, heated with crude oil. The charge is mixed with a slightly greater quantity of soda-ash and chalk in equal proportions. If there is much alumina in the ore a greater amount of soda-ash and chalk is added. Up to the present date, the conditions of roasting are still largely in the experimental stage. By careful pyrometric observations, the temperature is being regulated so as to control the conversion of chromite into sodium chromate of higher purity than the quality produced at first. At the time of my visit to the plant the roasting operations were conducted for periods ranging from 8 to 16 hours. After repeated rabbling the viscous mass is raked out upon a cooling-floor, where it appears as a dirty but characteristic yellow chromate of sodium.

The solution of this crude salt is effected by lixiviation in a series of tall cylindrical vats. Theoretically 100 parts of water dissolve 87.36 parts of sodium chromate. In practice a much larger amount of the solvent is used. Some difficulties are caused by the formation of sodium sulphate in the roasting-furnace, because this sulphate dissolves with the sodium chromate. It is probable that a desulphurizing roast of the ore separate from the sodium charge will prevent the formation of soluble sulphates. From the vats the normal chromate solution is pumped to the tannery, where it is boiled with sulphuric acid and converted into the bichromate. Special care is taken at this stage of the process to add no more than the exact amount of acid necessary to produce the required chemical change from Na_2CrO_4 to $\text{Na}_2\text{Cr}_2\text{O}_7$.

At this Napa tannery the rich green solution of sodium bichromate is run directly into tanks, where hides are 'paddled' by revolving blades that beat the chrome salt into the leather. This fixes the basic salt in the saturated skin, causing it to dry without wrinkling, and upon finishing the process of tanning, the leather is given the property of resisting extremes of heat and cold. Gloves made of chrome-tanned leather are most serviceable and pliable. Workmen that handle hot tools and other objects are generally supplied with gauntlets of this heat-resistant material.

Producers of chromic iron ore may well look to the industrial chemist for the sale of their high-grade ore. With such extensive deposits of chromite, soda, and lime rock available in California, a wide field for the manufacture of chromium salts appears to be available. In preparing the refined chromates for the market, it will be

necessary to go further than the stage practised thus far at the plant of the Sawyer Tanning Co. There the chromate, as soon as it is converted into the bichromate, is utilized at once in the liquid form. To produce the pure crystals the following steps must be taken: In roasting, extra care is required to prevent the formation of soluble salts other than sodium chromate. After lixiviation of the roasted pulp, the solution must be concentrated to 52° B. by evaporation and crystallized in lead-lined pans. The normal chromate crystals are then washed in centrifugals, dried and heated to about 30° in drying-drums or chambers. Under these conditions the crystals crumble into a yellow anhydrous powder that should contain over 95% of the normal chromate.

The bichromate of sodium is formed by dissolving the normal salt to a density of 40° B., and treating with sulphuric acid (chamber grade). This requires considerable exactness on the part of the operators, who will note the actual point of conversion by testing with potassium iodide and starch-paper. An excess quantity of the normal salt is added in order to bring the proportion of chromic acid up to 72.5%. The bichromate solution must be cooled in the vat until sodium sulphate, if present, crystallizes. Then the purer solution is drained off, filtered, and evaporated to dryness in an iron pot. Almost continuous stirring is necessary during the concentration of the super-saturated bichromate solution. The solidified salt should be rolled to a fine powder while hot before it is marketed. When pure it should contain 72.3% Cr_2O_3 .

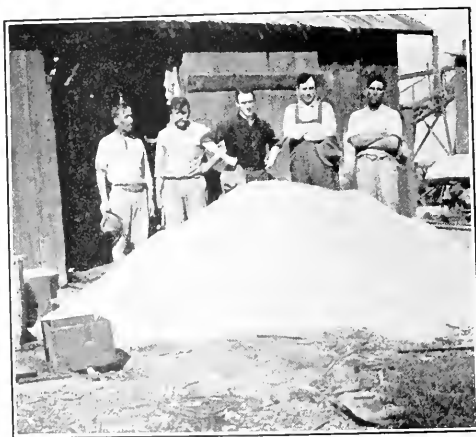
The process of manufacturing potassium bichromate is similar in many respects, only potassium lye is used instead of soda-ash. It is not generally known that this industry is conducted on an extensive scale in Europe. Great Britain alone produced 10,000 tons of potassium bichromate annually before the War. Since the sodium salts can be produced at far less cost than the potassium chromates and are ten times as soluble, the demand for sodium bichromate produced from Californian chromite and soda should greatly increase during the next few years. Not only will the flourishing tanning industry of California absorb a large amount of the bichromate production, but the demand for chromium compounds as mordants and pigments should greatly increase the demand for high-grade chromite ores.

Sampling of Mines

We are indebted to Mr. Morton Welber, of New York, for the following detailed description of his sampling of the American Girl mine, in southern California. The most interesting feature of this practice is the timing of the mixing so as to mix each sample equally.

The workings were sampled throughout the supposed orebody at intervals of 10 feet. In the raises and winzes sectionalized sampling was employed wherever desirable. In view of the low tenor of the ore, it was important that sampling should be accurate. An error that may be unimportant in medium or high grade ore becomes a large

proportion of the total content when the ore is low-grade. The sampling and cutting down was performed as follows: The original cut averaged about 10 lb. per foot. This mine-sample was reduced on the surface to pass half-inch holes. The entire sample was then mixed on a mat for a minimum of 5 minutes. Great care was taken to insure each sample being mixed for at least this period. A clock was furnished for this purpose. The work was under the constant supervision of a trained engineer. His duties were confined to this department. After the sample had been mixed, as described, it was then reduced by a Jones sampler, when it was ground to pass quarter-inch holes. The sample was then mixed again on a mat for 5 minutes, when it was cut down by a Jones sampler to approximately one pound and a half. The sample was then, without further reduction, ground in its entirety



DISCARD PILE AND THE SAMPLERS.

to pass 80-mesh, when it was again mixed for 5 minutes, prior to being split in duplicate. Great importance was attached to mixing. By this process each sample in its reduction from the original, which averaged between 50 and 60 lb. in duplicate, had been mixed for at least 15 minutes.

In order to check the accuracy of the sample as cut in the mine and also in its reduction to duplicate pulps, two systems of checking were employed. A series of cuts was re-cut and given different numbers from the original tags and were treated in every respect as separate samples in subsequent reduction and assay. The series checked to 25 cents per ton. This checked the accuracy in the cutting of the sample and its subsequent reduction. The sampling work was also checked by the assay of a series of duplicate pulps. The assays were in duplicate and they checked with the original pulps, as assayed at the mine, to 20 cents. The assaying at the mine was checked by a third system whereby a group of pulps that had been assayed were put into fresh envelopes and different numbers attached. The assayer was thereby caused to check himself, which he did to 20 cents. A flux and slag assay was run every day.

Flotation Concentration at Anaconda

By Frederick Laist and A. E. Wiggi

*Early in 1914 it was decided to test, on a fairly large scale, the treatment by flotation of Anaconda slime and tailing. For this purpose a standard Minerals Separation machine was installed at the Washoe Reduction Works during May and June 1914. This was followed by the installation of a full-size Callow pneumatic machine plant. Experiments were also made, on a smaller scale, with the Froment, the Towne, the Fields, and the Anaconda flotation machines. The last-named machine was developed at this plant. In addition to the tests made in the standard Minerals Separation machine, some tests were made using an M. S. machine of the sub-aeration type.

During the series of experiments a large variety of oils was tested. Experiments were also conducted using both round-table feed and tailing to determine whether it would be better to displace the round tables by flotation for the treatment of the slime, or to supplement the round tables by flotation of the round-table tailing.

A series of tests was also made on the treatment of the mill-tailing by grinding followed by flotation to determine the relative merits of flotation and leaching for the treatment of this product. In addition, flotation tests were made on mixtures of tailing and slime.

The round-table feed referred to above is the total slime from the mill.* It contains about 35% colloidal solids and approximately 90 to 95% of the total solids will pass through 200 mesh (0.067 mm.). It assays from 2.3 to 2.6% copper.

The mill-tailing mentioned is the total discard from the mill, exclusive of the slime. It is all finer than 2 mm. and about 90 to 95% will remain on 0.25 mm. It assays about 0.60% copper.

A series of tests was first carried out to determine roughly the best conditions for flotation, using the standard M. S. machine and treating round-table feed. The following reagents were tested either alone, or in combinations: turpentine, crude petroleum, cresylic acid, stove-oil, tar oil, Caroline oil of tar, argol, sludge-acid, fuel-oil, wood-cresote, and sulphuric acid. In some of these tests sulphuric acid was used, and in others it was omitted. Also the effect of varying the temperature of the pulp upon the flotation results was determined.

It was proved conclusively that the best combination of reagents for the treatment of our mill-products was sludge-acid, wood-cresote, stove-oil, and sulphuric acid. Fortunately, of all the reagents tested, these happened to be the cheapest. It was also proved that the addition of sulphuric acid to the pulp was of decided advantage

in the treatment of the slime. In two successive tests in which sludge-acid, wood-cresote, and stove-oil were used, the slime-tailing assayed 1.25% copper when no acid was used and 0.3% when acid was used. Since these tests were made we have omitted the use of stove-oil.

The M. S. machine had 16 agitator-compartments, each two feet square, and 14 spitzkasten, and was of the standard design. This machine is known by us as M. S. No. 1. The agitators were of the standard M. S. type, the impellers being 18 in. diam. and the agitators making 265 r.p.m. This gave the impellers a peripheral speed of 1245 ft. per min. The machine required 45 to 55 hp., including motor and belt transmission loss, when operating under a full load of pulp.

SUMMARY OF RESULTS WHEN TREATING SLIME

1. The economic capacity of the M. S. No. 1 machine when treating slime, as produced from the mill at present, is approximately 80 tons per 24 hours. We have found that the tonnage treated by the experimental machine, which had agitator boxes 2 ft. square, is to that treated by the full-size machine, with boxes 3 ft. square, as the cross-sectional area.

2. The best combination of reagents for the treatment of slime seems to be sulphuric acid, kerosene acid-sludge, wood-cresote, and stove-oil. There is some question as to the real value of stove-oil—its principal function being to make a more compact froth.

3. It would not be economical to retain the round tables, as the recovery by treating the slime directly by flotation is just as high as by retaining the round tables and treating the round-table tailing by flotation. The heating of the round-table tailing-pulp, on account of its low density, would increase the cost of flotation.

4. In treating the round-table feed directly by flotation, the resulting tailing should assay 0.30% copper, or less, with a concentrate carrying not over 40% insoluble. Possibly the concentrate can be made much cleaner with no sacrifice in the recovery.

5. It is thought that the best circuit-density for the slime-pulp in flotation treatment is about 12% solid.

6. It is thought that about 70°F. will be found to be the most economical temperature at which to keep the pulp.

7. Acid seems to be absolutely essential to the successful treatment by flotation of our slime.

8. The addition of air in the last spitzkasten is of no advantage.

9. Any considerable increase in speed of the agitators above a peripheral speed of about 1300 ft. per min. seems to be disadvantageous.

*Abstract of paper presented before the Arizona meeting of the American Institute of Mining Engineers.

SUMMARY OF RESULTS WHEN TREATING MILL-TAILING AFTER GRINDING THROUGH 60-MESH

These tests were made in the M. S. No. 1 machine. Dewatered mill-tailing was crushed through 60-mesh (0.25 mm.) in either a Hardinge mill, 10 by 4 ft., or a tube-mill, 8 by 12 ft. The grinding-mills were operated in closed circuit with a Dorr classifier, the overflow of the classifier being the final product of the system and going to the flotation plant for treatment.

1. Although not definitely demonstrated, it is thought that the economical capacity of the M. S. No. 1 machine when treating sand-tailing crushed through 60-mesh is about 175 to 200 tons per 24 hours.

2. The best combination of reagents seems to be kerosene sludge-acid and sulphuric acid. However, a mixture of cresosote, turpentine, and pine-oil, in a non-acid circuit gave good results also. The non-acid circuit, however, seems to require more delicate adjustment and more careful attendance than the acid-circuit.

3. The grinding-mill makes an ideal agitator, and it is of decided advantage to add the oil ahead of the grinders.

4. The treatment of the mill-tailing ground through 60-mesh should result in a tailing assaying not over 0.10% copper and a concentrate carrying not over 30% insoluble.

5. It is thought that the best density of pulp is from 25 to 30% solid.

6. Heating of the pulp to about 70° F. seems to be of advantage, although there is a possibility that this heating may be dispensed with during the summer months without any injurious results.

7. Acid seems to be beneficial, but it is not of as much importance as in the treatment of slime.

TREATMENT OF MIXTURE OF ROUND-TABLE FEED AND MILL-TAILING AFTER GRINDING THROUGH 60-MESH

These tests were made in the M. S. No. 1 machine. It was thought that it might be of advantage to mix the slime and re-ground mill-tailing for flotation treatment.

The average portion of sand-tailing to slime in the mixture treated was 75.7:20.1 or 3.8:1. In practice the proportion of production of tailing to slime is about 3:1; thus the mixture was somewhat deficient in slime.

Although the test was not conclusive, it was decided, from observation, that it is better to treat the slime and the sand-tailing separately. Of course, the slime made in the grinding of the sand tailing is included in the sand-tailing for treatment. This slime produced in grinding the tailing is much lower grade and more silicious than the original mill slime.

TEST WITH CALLOW PNEUMATIC MACHINE

The equipment recommended by J. M. Callow for test purposes was five standard Callow cells, 2 by 8 ft., a Pachua agitator and accessory apparatus, consisting of blower and sand pumps. In addition we built a set of two mechanical agitators. These agitators consisted of a tank about 10 ft. long by 21 ft. wide and 21 ft. deep, in which revolved a horizontal shaft carrying a set of

paddles. The agitators seemed to work well and had a combined capacity of about 60 tons of slime per 24 hours.

SUMMARY OF RESULTS WHEN TREATING SLIME

1. On our slime, air agitation is not as satisfactory as mechanical.

2. The capacity of one standard Callow cell is about 15 to 20 tons of slime per day.

3. The Callow machine makes a clean concentrate, but does not give as clean a tailing as the M. S. machine.

4. The Callow machine is more sensitive and requires closer attention than the M. S. machine.

5. The cost of repairs would probably be less on the Callow machine than on the M. S. machine. This cost, however, is comparatively small for either machine.

6. The power required per ton of slime treated in the Callow system is just about the same as that required in the M. S. machine.

In all these tests the original feed was divided among the Callow rougher-cells, operating in parallel. As a rule, there was one cleaner-cell operating also. When this was operating the concentrate from the rougher-cells went to it, the cleaner making a final concentrate and a middling that was returned to the system. The rougher-cells made the final tailing.

TREATMENT OF MILL-TAILING IN CALLOW MACHINES AFTER GRINDING THROUGH 60-MESH

During the first few shifts the mechanical agitators at the Callow plant were used, but it was soon found that they were not required; that the grinding mill gave sufficient and thorough agitation.

Kerosene sludge-acid was the only oil used during this period, and was added ahead of the grinding-mill. Sulphuric acid was added ahead of the flotation-cells. The tailing for this period average 0.10% copper and the concentrate carried an average of 42.2% insoluble. The pulp was heated just ahead of the flotation-cells.

1. The capacity of the standard Callow cell when treating ground mill-tailing is about 75 tons per day.

2. No other agitation is required if the reagents can be added ahead of the grinding-mill.

3. The use of acid seems to be of considerable advantage.

4. On account of utilizing the grinding-mill as an agitator the Callow machine requires less power per ton treated than the M. S. machine.

5. The Callow machine is more sensitive and requires more attention than the M. S. machine.

The work of the Froment, Towne, and Fields flotation machines was found to be unsatisfactory; that on the Anaconda cell was of short duration, no definite results being obtained.

The conclusions drawn from the foregoing tests were that the Minerals Separation machine was best adapted for the flotation work at Anaconda. Furthermore, that the most efficient reagents would be sludge-acid kerosene, wood cresosote, and sulphuric acid.

The froth in the flotation concentrate was broken up by a circular disc revolving in a tank.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

CRUSHING in a ball-mill is the result of two actions, the impact of the falling balls and the abrasion due to their rolling.

FEW PERSONS can receive a shock of 500 volts of electricity without serious, if not fatal, effect. Instances have been recorded, however, of men surviving a shock of several thousand volts.

CRUDE PETROLEUM is used at some mines as a dressing for hoisting-ropes, and for this purpose some kinds of crude oil are excellent, but care should be taken to obtain oil as free as possible from sulphur.

POTASH from the flue-gases of blast-furnaces treating iron ores is a commercial possibility and may become an important source of supply. The Cottrell process is used to precipitate the solids from the gases.

SHEET-PIILING of wood, metal, or concrete is most useful in excavating through water-saturated ground or quicksand. When properly placed and driven, practically all the water, except that entering from below, is excluded by this method.

ASPHALT was used extensively in the construction of the palaces of Nineveh and Babylon, the tower of Babel, and the temple of Solomon. Many evidences of these remain in the petroleum-cemented walks that have endured for more than 3000 years.

CARBON MONOXIDE to the extent of 0.2% is dangerous to life if breathed for one-half hour. Larger amounts may be fatal in correspondingly shorter intervals of time. Not more than 0.05% carbon monoxide should be allowed in any mine working at any time.

THERE is no method of determining sulphuric acid in presence of sulphates except by titrating the solution with standard alkali and methyl-orange indicator. In some cases the end-point is obscured owing to precipitation of metallic hydroxides before the point of neutrality is reached.

A NOVEL METHOD for testing detonators is used in New Zealand. The detonator is crimped on a short fuse and hung so that the detonator touches the centre of a lead plate. Upon firing by the fuse, a small crater is cut in the plate, with scratches radiating from the crater as a centre. The extent of the marks is a measure of the force of the explosion.

QUALITY OF AIR in mine-workings is affected by the consumption of the contained oxygen and by the production of poisonous gases. The consumption of oxygen and

the production of carbon dioxide is accomplished by, breathing of men, burning of candles or lights, oxidation of timbers and carbonaceous rocks, and by blasting. Poisonous gases are usually produced by the blasting but may also result from the rotting of the timbers.

STAMP-MILL SHOES and dies have no standard size. Both are made of various weights, the chief difference in weight being generally due to the variable height. In shape the main difference is in the form of the shank, or neck, of the shoes, and in the corresponding socket in the bosshead. One foundry in California has no less than 40 different patterns for shoes and dies, no two of which are alike. Undoubtedly if a standard of size could be adopted it would be welcome to mill-men.

GOLD associated with calcite is by no means uncommon. In some instances the gold occurs in veins having a gangue of both calcite and quartz, in others the material is pure crystallized limestone. At the Alford mine, 25 miles north-east of Daggett, in San Bernardino county, California, coarse gold occurs in crystallized limestone, and a similar occurrence has been noted near Box Spring, 40 miles east of Victorville in the same county. At the Carbonate mine, near Oro Grande, coarse gold was found in small veins of calcite and quartz, cutting limestone and schist. These little veins were small offshoots of a large vein-like mass of limonite with lead carbonate, occurring as a replacement of limestone. Many are prejudiced against limestone as the formation for a profitable gold mine, but there is no good reason for antipathy to any formation known to carry gold, such as limestone, quartzite, or any other rock.

ALUMINUM-CHIPS from castings, used in the manufacture of automobiles, have become a valuable source of aluminum. By the old methods of treatment the recovery of the metal was about 60%, although 90% is commercially possible. Recent investigations by the United States Bureau of Mines has shown that the causes of the high loss in the usual method of melting chips is due to the difficulty of causing coalescence of the tiny globules of molten metal which are covered with a skin of oxide and dirt. Two methods can be successfully used to promote coalescence. In one method the chips are kept just above the fusion-point and the globules made to coalesce by hand-puddling, which breaks through the skin and makes the globules unite. In this method, melting is done in an iron pot heated by oil. The other method is the use of a flux that dissolves the skin of dirt and oxide, producing clean globules which can unite. The flux suggested is 85% common salt, 15% fluorspar, used in large amount (20 to 30% of the weight of chips) and mixed with the chips before charging. High temperatures are required by this method which makes the iron-pot furnace impracticable. Melting is done in graphite crucibles or in a reverberatory-furnace. Since the presence of dirt and oxide causes low recoveries, care must be taken to prevent contamination of the chips with dirt, oil, or oxidation.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

ROCHESTER, NEVADA

INTERESTING MINING AND MILLING NOTES FROM A SHAVER DISTRICT.

Through the declaration of its initial dividend of 5c. per share, payable on December 20, the Nevada Packard company has been the centre of interest in the Rochester district during the past week. Milling operations began in December, 1915. Recently a number of interesting changes were made in cyanidation practice. The grinding unit originally consisted of a 6 by 5-ft. and a 6 by 10-ft. tube-mill in closed-circuit with a Dorr classifier. The former was converted into a ball-mill after reducing the diameter to 1 ft. 4 in., with a resulting increase in tonnage from 95 to 130 tons per day. Power consumption remained practically the same. The necessary increase in settling capacity was obtained by the use of glue as a settling agent, $\frac{1}{16}$ lb. per ton of ore being added, after dissolving in warm water. Laboratory experiments proved its efficiency on this ore. The appearance of refractory sulphides in the ore led to the installation of a canvas table test-plant between the last agitator and the C. C. D. thickeners, the original intention having been to return the concentrate to the tube-mill circuit for further grinding. The concentrate proved to be higher grade than expected, and will probably be shipped to the smelter, the lowering of tailing loss more than balancing the increased cost. This is interesting in view of the fact that at both the West End and Extension mills at Tonopah, concentration was recently discarded on silver sulphide ores. On a basis of 3263 tons treated, the October costs at the Packard were

Mining	\$1.46
Milling	1.23
Development	0.62
Total direct cost	\$3.31
Office and general	0.46
Marketing	0.29
Total indirect cost	\$0.75
Total cost per ton	\$4.06

This is exclusive of interest and depreciation. J. W. Wilkey is superintendent.

At the Packard North Extension the main adit is being driven to cut the extension of the Packard orebody, under the direction of Leo Hocorton, lessee. The tunnel has been driven 800 ft. through hard rhyolite, entirely by hand work.

A promising vein containing silver-bearing calena and cerussite is being developed by J. C. Eppeleheimer, on his claims adjoining the Packard on the west. A fair sized ore dump has been accumulated.

The Rochester Mines Co.'s mill at lower Rochester is treating 120 tons of ore daily. The new additions will probably begin operations in December, increasing the daily capacity to 200 tons. The contract for the three-mile tramway, connecting mine and mill, has been let, but actual construction has not yet begun. The haulage cost per ton will be cut from 50c. to 20c., or less. The ore is now being hauled by the Nevada Short Line Railroad, a narrow gauge road built during the boom days to connect Orondo, on the Southern Pacific, to Rochester. It is now in receiver's hip.

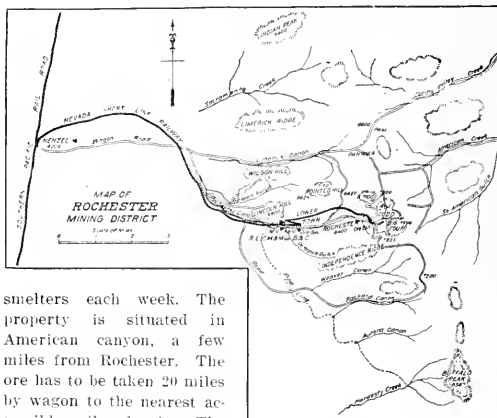
Former lessees have resumed work on the Buck and Charley

at Lower Rochester. A number of shipments of rich ore were made from this property during the early days of Rochester.

It has been persistently rumored for some time that the Tonopah Belmont-Jim Butler people were acquiring interests in the Rochester district. The election of Clyde Heller to the vice-presidency of the Merger company confirms these rumors. The cyanide-plant may now be expected to replace the printing-press as a method of ore treatment at at least one property.

Some work is being done on the Lincoln Hill mine. It was equipped with a five-stamp amalgamating mill about two years ago. This appears to have been built for decorative purposes only.

The American Mining Co. is shipping a lead-silver ore to the



smelters each week. The property is situated in American canyon, a few miles from Rochester. The ore has to be taken 20 miles by wagon to the nearest accessible railroad point. The shipping ore is accumulated by hand-sorting and jigging. It is probable that a small concentrating plant may be erected in the spring. A. L. Russell of Rochester is in charge.

Rose creek, on the Southern Pacific, 12 miles below Winnemucca, was a scene of some excitement last week, due to the discovery of some high-grade silver ore. The veins are only a few inches wide. A 40-ft. shaft constitutes the deepest workings so far.

Lee Campbell and associates, of Packard, are pushing development on their property at the head of Say canyon, a few miles west of Kennedy. The deposit is an extremely interesting one, due to the diversity of mineralization. Three grades of ore are sent to the smelter, payments being made for gold, silver, copper, and lead-content. The owners hope to be able to sort out an acceptable zinc product. The veins are extremely rich, yielding a profit after hand-hammer mining, hand-sorting, and wagon haulage of 57 miles, to Mill City. Such a variety of metals occurring in one property is, of course, a rare occurrence in this district, although it is characteristic of the Humboldt range as a whole. Within a radius of 25 miles of Rochester, gold, silver, copper, lead, zinc, antimony, tungsten, and quicksilver ores are being produced on a commercial scale.

The average number of men employed at the larger properties of the Rochester district is as follows: Rochester Mines Co., 70; Nevada Packard Mines Co., 52; Rochester Merger, 35; Nenzel Crown Point, 30; Rochester United, 7; and Limerick, 5.

SUTTER CREEK, CALIFORNIA

CENTRAL EUREKA SINKING SHAFT.—SOUTH EUREKA.—LINCOLN CONSOLIDATED TO RE-OPEN OLD MINES.—ORIGINAL AMADOR.

The Central Eureka Mining Co. began sinking its shaft below 3200 ft. two weeks ago, the idea being to increase the depth sufficiently to permit the opening of two new levels below the present bottom of the mine. Waste from the sinking is not carried above 3100 ft., being used for filling, regular mining operations are practically uninterrupted, and sufficient ore can be hauled from the main working levels to keep at least 20 stamps dropping. The company first contemplated sinking a winze on ore at 3200 ft., but this plan was abandoned. Cross-cutting a short distance to the vein will be necessary and then raising and stoping. The company reports a cost in October of \$1090 for watchmen's services as a result of the recent strike. Considerable repair work was done in the shaft and preparations made for sinking so that all of the time was not wasted while actual mining was suspended. The report shows the total expense for October to have been \$3129, of which repairs consumed \$577; pumping, \$383; enlarging and strengthening tailing dam, \$318; assaying, \$77; mill improvements, \$20; general expense, compensation insurance, etc., \$664, leaving a balance on hand of \$1236, which will be increased by the present month's gold yield and the 3c. assessment payable on or before December 1.

Forty stamps of the South Eureka company's sixty are now in operation, and the property is gradually being put into shape for greater production. The general manager, H. Maloch of San Francisco, visited the property last week.

Articles of incorporation of the Lincoln Consolidated Mining Co. were filed at Jackson last week, and considerable interest is taken in the current rumor that operations will commence in the near future on this Sutter Creek property, which the former Lincoln company sold last spring to T. Hoatson and other Michigan capitalists. The company is capitalized at \$250,000, and its holdings include the Wildman, Mahoney, Lincoln, Emerson, and several adjoining mining claims, all of which have been idle for a number of years. The Lincoln shaft has a depth of 2000 ft., and from the lowest level, 1950 ft., a long cross-cut was driven under the Mahoney 1200-ft. shaft toward the Wildman shaft a few years ago, with the intention of connecting the three properties. On the 1400-ft. level of the Wildman property, an immense body of low-grade ore was cut, which will be profitable when the mine is properly equipped. The Emerson shaft was sunk in diabase 1000 ft. east of the Wildman shaft to cut the Wildman vein at a vertical depth of 2300 ft., but had attained a depth of only 619 ft. when operations ceased for lack of money. The property stands high in local esteem, and a great future is predicted for it if properly equipped and opened on a large scale. There are two 40-stamp mills on the ground, but these and the hoisting plants are antiquated and will doubtless all be replaced by modern machinery.

During the past week progress of from 10 to 20 ft. per day has been made in unwatering and repairing the Old Eureka shaft, and the repair crew has now reached the 1000-ft. station, which is about 950 ft. from the surface, the distance between several stations not measuring the usual 100 ft. Timber in this portion of the shaft, so many years under water, appears in a remarkable state of preservation. Twenty-eight inch logs, hewn flat on two sides, were used extensively in this old shaft, and these immense timbers appear as sound as when they were first put in. A large tank and pump for lifting the water from the lower levels will be installed at the 1000-ft. station, and an 18-in. concrete floor is now being laid for this purpose. The forms are ready for pouring concrete, and some concrete has been run in for the 36-ft. piers, which will support the new head-frame. The tops of these piers are on a level with the newly-erected engine standing on the hanging-wall side of the

shaft. The hoist now in use is on the foot-wall side. The low ground around the collar of the shaft is to be filled in to the top of the concrete piers, making the ground level between the hillside and the old waste dump that borders the wagon-road. This will bring the shaft-collar on a level with the timber-shed and compressor-room, and will be a great improvement over present conditions. The head-frame, which is to be built of steel and heavy timber, will extend 92 ft. above the concrete piers. Concrete foundations for the large hoist are now being laid. Good material and workmanship is evidenced in all the company's surface construction, and strong foundations for buildings and machinery denote faith in the future of the mine. Excellent progress has been made in re-opening and equipping this old producer, considering that eight months ago there was nothing to be seen on the property save the depressions around caved shaft-collars. It now appears probable that the shaft will be cleared to the bottom early in January. After that it is understood that the company contemplates sinking a vertical shaft on the Frakes ranch, and later erecting its mill on the Goodman ranch, both of these properties having been purchased by the present company and added to the original Old Eureka holdings.

BUTTE, MONTANA

NORTH BUTTE AT DEPTH AND IN EASTERN PART OF DISTRICT.—
BUTTE GREAT FALLS, GREAT BUTTE COPPER, AND BULLWHACKER.

North Butte's Granite Mountain shaft has been sunk to a depth of over 3700 ft. Stations are being cut on the 3200, 3400, and 3600-ft. levels. Development will be hurried at these depths, to open a large quantity of ore. High temperatures that interfere with ventilation have tended to increase underground costs, and the cool weather and ventilating appliances that have been installed in the deep workings will be of great benefit. Forcing air through a canvas hose into the face has been found to be the most satisfactory way of ventilating the places that are situated a long distance from a shaft. Ore averaging 2½% copper can now be extracted at a profit, and a much lower grade of ore is being mined while the metal is high in price. Zinc ore has been developed on the 2000-ft. level, where the vein is 10 ft. wide and averages 20% metal. Several carloads were shipped to the Great Falls plant of the Anaconda company containing 17% zinc. The metal-content is expected to be higher when stoping is commenced, as there will then be a better opportunity to keep waste out of the ore. Development in the eastern part of the district, where a tunnel is being driven on the Northwestern claim, has disclosed some small sulphide veins, one of which was 18 in. wide, assaying 3.2% copper and 2.6 oz. silver. The adit is not yet in far enough to cut the large veins that are exposed on the surface, but indications are favorable and point to an extension of mining operations in this part of the district on a considerable scale.

The Butte-Great Falls company has levied an assessment of 5c. a share. This will yield \$30,000 for the treasury. A heavy flow of water was encountered on the 500-ft. level, and a new electric pump will be installed. It is also proposed to drive a drainage-tunnel that will open the 500-ft. level. Butte-Great Falls owns 186 acres north of the productive area of the district, and the veins cut at 500 ft. did not contain profitable ore. Many of the Butte veins are non-productive in the upper levels, and there is a good chance that the Butte-Great Falls veins would be productive if they were opened at a depth of 1000 ft. The company may commence operations in the Nelhart field. Several of the old silver-lead properties there are being examined.

The Great Butte Copper Co., successor to the Butte & Bacorn company, which owns claims between the Butte & Superior and Butte-Great Falls, has completed its surface plant, and un-

watered and repaired the shaft to a depth of 450 ft. It is believed that the shaft is in good condition below 500 ft., and the remainder of the water can probably be bailed out. The shaft is 1025 ft. deep, and will be sunk an additional 500 ft. Cross-cuts are to be driven on the 1000 and 1500-ft. levels to intersect veins that have been found on the surface by a network of trenches and adits.

Bullwhacker's production from its open-cut is greater than before. Underground development is also encouraging, and sub-lessees are working in different parts of the property with such success that the North Butte, which owns adjoining ground, has had many applications for leases. Much of the copper-content of the ore is in the form of silicate, and it is not probable that North Butte will mine the ore until a more economical method of treatment has been devised.

TORONTO, ONTARIO

INTERESTING NOTES ON METAL PRODUCTION DURING THE PAST NINE MONTHS.

The Bureau of Mines has collected returns from the metalliferous mines and works of Ontario showing the production for the nine months ended September 30, 1916. Following are the figures for the period, and for purposes of comparison, those for the corresponding period of 1915. It will be noted that there has been a large increase in the aggregate value, and also in the value of nearly all the individual products, due to causes mentioned in the notes appended.

Product	Quantity		Value	
	1915	1916	1915	1916
Cobalt (ore), tons	92	98	\$ 12,472	\$ 10,591
Cobalt oxide, pounds	135,337	378,732	107,363	231,947
Cobalt metallic, pounds	76,979	172,955	66,552	146,467
Cobalt and nickel oxides (unseparated), pounds	2,501	57,926	500	22,890
Copper ore, tons .....	.....	1,715	.....	21,685
Copper in matte, tons	14,057	16,989	2,024,658	6,285,930
Gold, ounces	281,712	363,955	5,826,941	7,513,734
Iron ore, tons	302,586	271,034	601,044	673,170
Molybdenite (concentrate), pounds .....	.....	15,845	.....	15,845
Nickel oxide, pounds	142,483	54,152	16,085	6,281
Nickel metallic, pounds	11,905	17,435	4,762	7,618
Nickel in matte, tons	24,054	31,046	5,369,536	15,523,000
Pig iron, tons	354,153	501,410	4,510,906	6,686,965
Silver, ounces	17,178,629	16,203,091	8,030,469	9,750,040
Total value			\$26,571,288	\$46,896,263

COBALT. The silver mines of the Cobalt district have definitely established their supremacy among sources of the world's supply of this metal. Notwithstanding the War, which has closed the European markets, shipments of cobalt oxides were much greater, both in quantity and value than in the first nine months of 1915. It will be observed that metallic cobalt is assuming an important place in the list. This is mainly due to its use in the manufacture of special alloys, principally stellite, for high-speed tools. Stellite is made of cobalt, chromium, and tungsten, and is finding a good demand from munition-makers and other workers of modern hard steels.

GOLD. The output from the mines of northern Ontario is steadily increasing, being 28% in excess of that for the nine months of 1915. Hollinger Consolidated continues to be the chief producer, accounting for 47% of the total. Dome followed with 21%, and McIntyre-Porcupine with 10%. The other important contributors at Porcupine are the Porcupine Crown, Schumacher, Vipond, and Jupiter, which together furnished 5.5%. Outside of Porcupine proper, Touch Oakes yielded \$519,149; Canadian Exploration, Croesus, and a small output from Dome Lake, amounted to over \$250,000. At Teck-Hughes (Kirkland Lake) the mine has been developed and a mill

built, which will be put in operation as soon as the power transmission-line now being erected from Cobalt is completed. Other prospects here, the Lake Shore, Wright-Hargrave, Kirkland Lake Gold Mines, La Belle-Kirkland, and Sylvanite are also being developed. This is a promising centre. In Gauthier township the Huronian mine is being worked under lease. Several discoveries of gold were made during the summer in Benoit township, but there has not been time to prove their value. At Tashota, the Tash-Orn company has bought the Wells' claim, and has erected machinery to give it a thorough test. This company is also working the King-Dodds claims. A diamond-drill has been operated on the Devanney, Reamsbottom, and Clive claims.

MOLYBDENITE. There is a demand in England for making tool-steel, and several deposits of the ore in eastern Ontario have been opened and are being worked. There are dressing plants at Renfrew and Ottawa, the latter operated by the Dominion Mines Department. Ferro-molybdenum is also being made at Orillia and Belleville. The supply of molybdenite throughout the British Empire has been reserved as a war measure, and a price of 105 shillings (\$25.20) per unit fixed for concentrate delivered at Liverpool. This approximates \$1 per pound here.

NICKEL. The Canadian Copper and the Mond Nickel companies have been working their mines and smelters at maximum capacity, and the output of nickel, contained in the matte product of the furnaces, for the nine months falls little short of that for the full year 1915. The production for 1916 will

probably exceed the production of 1915 by 20%. The valuation of the nickel in the matte has been increased from about 11c. per pound (the figure adopted by the mining companies) in 1915 to 25c. per pound in 1916.

SILVER. The mines at Cobalt continue to produce, though on a slowly diminishing scale. The quantity contained in the shipments of the nine months was 975,538 fine ounces below the record for the same period of last year; but owing to the much higher prices that have prevailed for silver the return to the mining companies was \$1,719,571 greater. Silver started the year at 56.76c. per ounce and rose to a maximum in May of 74.27c., when it receded to 63.06c. in July, reaching 68.51c. again in September. In 1915 the monthly average was 49.75c. per ounce. Nipissing still leads in production, Mining Corporation coming next, followed by Kerr Lake, Coniagas, McKinley-Barragh-Savage, Seneca-Superior, Temiskaming, etc. The flotation process is likely to assist materially in increasing the production of silver at Cobalt. It has been introduced at the Buffalo mine, where it is treating successfully low-grade ore containing 5 or 6 oz. per ton. From the gold ore treated during the period 66,347 oz. of silver was obtained, and from the copper ores 607 ounces.

A large increase in pig iron is recorded.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE. Three carloads of coal daily are being hauled from Moose creek on the Matanuska branch of the new railway for consumption at Anchorage. The population of this place is now over 4000. Large areas of land are being taken up for agricultural purposes.

ARIZONA

AGO. Over 400 Mexican miners employed by the New Cornelia Copper Co. are on strike, demanding the sliding-scale for their wages. Twenty carpenters previously downed tools, after asking for more pay.

CHLORIDE. Mines and dumps in the district are being sampled by the Western Ore Purchasing Co., F. M. Manson, general manager, to see whether a sampling-plant is warranted.

The custom mill to be erected by F. E. Steffey and others of Chicago is to be centrally situated on a hill-side.

The Tennessee mine is employing 150 men, and is shipping three carloads of ore daily to Needles. Electric power is to be available as soon as the motors are in place.

Roads into the district are to receive attention at an early date.

JEROME. In 7 days the United Verde Extension shipped 70 carloads of rich ore to smelters, a record. The 1300-ft. level is opening as well as No. 14. Plans are being prepared for a smelter. Limestone can be secured nearby.

MIAMI. The Miners' Union voted on November 27, 28, and 29 on the question of closed shop and raising the minimum of sliding wage-scale from \$3.50 to \$4 per shift. Miners are now receiving \$5.25 with copper at the present price. The Globe union decided to take no action; also that at Miami.

The Old Dominion mine is producing 1200 tons of ore daily, while three blast-furnaces and one converter are making 45 tons of copper each 24 hours. By connecting the two ends the west foot-wall drift on No. 18 level, ventilation and ore-handling is improved. The flow of water in the mine is under 5,000,000 gal. daily. Drilling and grouting of Pinal creek continues with the object of lessening the inflow of water. Flotation equipment is to be enlarged.

(Special Correspondence.)—Three modern gold reduction plants are being constructed, or will soon be under way, in the Oatman district. They will have a combined capacity of from 1300 to 1500 tons of ore daily. The United Eastern 400-ton mill is practically complete and will be operating within the next 30 days. The plant was well designed. The ore will be crushed by both ball and pebble-mills, while the counter-current decantation system of cyaniding will be used. A total mining and milling cost of \$3 per ton is estimated when the three new plants are in operation. The other two plants are being designed for the Tom Reed and Big Jim companies, the former with a daily capacity of 500 tons, and the latter 400 or 500 tons. The new Tom Reed plant will be erected just below the Aztec shaft, where a large body of ore is now being developed. This deposit is now being explored by sinking a shaft to the 800-ft. level (now down 500 ft.), and by driving on the 400-ft. level. It is 30 ft. wide, 1600 ft. long, and averages from \$15 to \$20 gold per ton. Orders have already been placed for the electrical equipment and some of the machinery, as from five to seven months' time is necessary before deliveries can be made. The general plans and specifications of the Big Jim mill are completed, but before the type of ma-

chinery is decided on, the manager, A. G. Keating, will spend a month or more studying the latest methods being used in gold and copper plants throughout the country. The Big Jim mill will be built just west of the working-shaft of the company. With these three mills reducing 1500 tons of ore daily, the output of bullion is estimated at \$30,000 per day.

Ore treatment by an entirely new process is being done at the Gold Dust plant. This process consists of a Marks rotary pulverizer and a Zimmer centrifugal separator, a combination which it is claimed will reduce treatment costs to \$1 per ton. If this end is achieved it will mean that many properties in the district having reserves of low-grade ore will be able to mill it at a good profit, which has not been possible with costs of mining and milling running from \$8 to \$10 per ton.

Oatman, November 22.

PRESCOTT. The *Courier* states that it is almost certain that Prescott will have a large custom smelter. Representatives of the Anglo-Saxon Smelting & Refining Co. are due here from England at the end of December. H. R. Croup is president, and J. E. Russell of Prescott is attorney. Options may be taken on several groups of claims. The town authorities have provided a smelter-site for the company.

ARKANSAS

In the Buffalo River district five new concentrating plants are being erected to treat the zinc ore. Ore production from the north Arkansas field in November is expected to heat that for October, the record month.

CALIFORNIA

The report of the State Mining Bureau for the week ended November 25 shows 13 new wells starting to drill, making a total of 663 since the beginning of the year. Six wells are to be deepened or re-drilled, and three abandoned. There were 16 wells ready for test or shut-off, which is usually inspected by officials of the Bureau. Since the first of the year there have been 820 such inspections that have absorbed the greater part of the time of the Bureau staff. This work has been given particular attention, for the reason that it has insured that new or repaired wells would be completed in such a manner as to prevent damage to the oil-fields by infiltrating water. However, this work is of less ultimate value than outlining proper development methods to meet various geological conditions, and steps are being taken to alter the procedure when tests are made so as to enable the Bureau to perform its more important functions. The routine work of testing has prevented widespread study and correction of damage done by improper work through the past 15 years, but a few such cases have been acted upon, and prove that repairs properly made will greatly increase the value of some properties which were badly flooded. One of the most remarkable cases of improvement is at the property of the Del Rey Oil Co. in the Kern River field, where the proper plugging of a well, by the owners working in co-operation with the Bureau, has materially decreased operating cost and also increased the productiveness of the property.

CALIENTE. About five tons of high-grade antimony ore is being shipped daily from the Big Fifty mine, 15 miles away. A mill may be erected for the lower-grade ore. The Fifty Associates Securities Co. of Los Angeles is owner.

CRESCENT MILLS. The old Crescent gold mine, one of the best

producers in the Indian Valley district of Plumas county, is being re-opened by the Philadelphia Exploration Co. The mine is to be unwatered and the mill re-built. Albert Burch is in control, with A. Buckbee as superintendent.

GRASS VALLEY. The old Syndicate holdings of 53 acres have been acquired by the Grass Valley Consolidated Gold Mines Co., owners of the Allison Ranch mine. The area of this company is now over 200 acres. The Allison Ranch will be able to mine several veins apexing in Syndicate property.

GROVELAND. The Flap Jack gold mine in Tuolumne county, fairly well equipped, has been bonded to Honolulu and New York sugar interests for \$50,000. D. Dana is making an examination.

(Special Correspondence.)—Construction of a three-mile road from the Gray Eagle copper mine to Happy Camp in Sis-

company has opened two good quartz veins on Horse creek, and is preparing to hurry developments.

Happy Camp, November 24.

HAMMONTON. On Sunday, November 26, the Yuba Consolidated launched the steel hull of No. 16 dredge. The exercises were preceded by a turkey dinner and band concert. The hull cost \$150,000, and the completed boat \$500,000. Instead of stacking tailing behind it in the river, two belts will discharge the gravel on the banks of the river.

MARYSVILLE. A temporary injunction has been allowed the Yuba Consolidated in its suit against the Marigold Dredging Co. restraining the latter from operating a dredge on land in dispute. The Court is to decide on December 8 whether the injunction be made permanent or not.

MOKELUMNE HILL. In a new shaft being sunk by lessees of



SURFACE PLANT OF CALAVERAS COPPER CO., COPPEROPOLIS, CALIFORNIA.

kiyon county proceeds. It is hoped to have it complete before winter. Arrangements have been made for installation of much equipment in the early spring. It is reported that a concentrator will be erected and that concentrate and shipping ore will be sent to the Thompson smelter of the Mason Valley Mines Co. This company recently acquired the Gray Eagle and is directing operations. William Hoerner is superintendent. Ore reserves are estimated by competent engineers to be considerable.

Numerous copper deposits in this district are claiming attention. At the Ely on Elk creek, an adit is being driven to intersect the vein exposed near the surface. The orebody averages 15 ft. in width and has been traced for 2000 ft. Recent assays gave 18% copper and \$20 in gold and silver.—Considerable work is going on at the Williams claims, lately taken under bond for \$50,000 by San Francisco people. J. E. McCoy is pushing the work at the Fairview, adjoining the Williams mine.—H. G. Boone has sold his interest in the Bon Ton group to M. A. Delano, of Grants Pass, Oregon, who is arranging for vigorous work. The W. R. West company has opened high-grade copper ore at a point 18 ft. in from the adit portal.—Several deals have been reported in the past month.

Gold mining is also active. From the Bradley mine, on Independence creek, a 12-mile road is being built to Klamath river, where it will connect with the highway. Plans have been drawn for a mill and cyanideplant, and operations are soon to begin. Rich gravel is being worked at the Atterberry Brothers' property, and an elevator will be installed in the spring. The main deposit is said to be 300 ft. wide and 8 to 24 ft. deep. Preparations are being completed for resumption of hydraulic mining at the Davis Consolidated, one of the largest placer properties in the county. The Savage-Johnson

the old Garibaldi mine, 8 miles away, rich gold ore has been opened at a depth of 50 feet.

PLYMOUTH. The Plymouth Consolidated reports as follows for October:

Ore milled, tons	7,900
Gold recovered	\$52,385
Working expenditure	24,931
Development	6,783
Surplus	20,671
Other charges, construction	6,662

COLORADO

BOULDER. The tungsten market is improving, buying being better. The Primos, Wolf Tongue, and Vasco companies are preparing to re-open leases and encourage miners to renew operations. Degge-Clark and other leaders in the independent market are receiving all the lower-grade ores offered, and much activity is observable on the part of independent miners.

A region of especial geologic as well as economic interest is that described in Bulletin 265 of the U. S. Geological Survey, entitled, 'Geology of the Boulder District, Colorado.' The area shown on the maps accompanying this report is a quadrangle measuring 16 miles from north to south by 9 miles from east to west, of which Boulder is practically the centre. The discovery of coal, oil, and gas in the region first called attention to it, and was the immediate occasion for the survey which resulted in the publication of this bulletin. The structural and other geologic features of the area, including the folds, faults, landslips, and mesas, afford attractive subjects for study and comparison.

CRESSON CREEK. In addition to its monthly distribution of \$122,000, the Cresson company will pay \$183,000 on December

10. Shares are quoted at \$9. The mine is said to be in a favorable condition. The gold output of the district in November was \$1,311,356 from 75,623 tons of ore.

GEORGETOWN. The mining situation in the Georgetown and adjoining districts is better than it has been for a long time, according to the *Courier*, and although there may seem to the casual visitor an appearance of want of 'get-up' to the town, it is more greatly due to past years of stagnation in mining, which was general throughout the United States, than to the present condition of business here. At the present time more mines are being worked and more men employed in this and neighboring centres than has been the case for years, and what is better still, more ore is being produced, ore of all grades from \$10 to \$200 per ton, and in large quantities. This being the case, why is not every mine and prospect in the vicinity being worked? The ores contain gold, silver, lead, copper, and zinc, the prices for all of which are higher than they have been, and at prices which have prevailed for a good while past, all these metals can be mined at a good profit under practical business management. The want of practical business methods as applied to mining has been the great cause of failure. The one big and most glaring reason why more mines here are not worked is the want of proper publicity, and this will never be given to the district as long as it stays in a rut. It takes capital to open any business, and although there may be good ore in the mine, still capital is needed to get it out and market it to the best advantage. Capital is what we want. How are we going to get it? This is up to the businessmen and miners of Georgetown and not to any one else. No one is interested but ourselves.

LEADVILLE. The higher price for silver is pleasing to producers in this district, as most of their ores contain a good deal of the metal, the aggregate being nearly 3,000,000 oz. yearly. The Dinero and Louisville mines yield ore assaying up to 1000 oz. per ton.

At Robinson the Progress M. & M. Co. has re-built the old Wilson mill, and is now operating it in conjunction with other mines under its control.

John Cortellini, manager of the Garbutt and other properties on Breece hill, has just returned from a short tour through the important zinc-fields of the country where the latest methods of mining and treatment are in vogue. He said that every mine has its own concentration plant. It is conservatively estimated that it is necessary to concentrate at least 75% of the total output from the mines before shipping to the smelters. Mr. Cortellini is a strong advocate of milling, and considers that if concentration has been found to be such a remarkable success in zinc mining throughout Missouri, it should be of great benefit at Leadville, where there is at present only one mill in operation. Much of the ore that is being extracted from the Garbutt and Ibox properties needs concentration, and Mr. Cortellini is still engaged in an effort to perfect suitable plans for the erection of a large mill in the district for treating this ore. The Garbutt and Ibox are now producing 450 tons daily for the smelters.

SILVERTON. Twenty companies shipped a total of 49 carloads of ore and concentrate last week. Owing to the alleged action of the D. & R. G. Railroad it is expected that there will be a coal famine in the district. Durango coal, usually \$6.25 per ton, is now from \$8.50 to \$10.

IDAHO

BURKE. The Marsh workings that are flooded are to be unwatered as soon as possible, and search made for the eastern extension of the Tiger-Poorman vein, from which the Federal company extracted \$5,000,000 net.

Development is to be resumed at the Ajax and Ambergis companies, whose claims adjoin the Hercules lead-silver mine.

The control of the Hercules mine, a large silver producer, has passed to the Day interests of the Coeur d'Alene,

through the purchase by Mrs. Eleanor Day Boyce of Portland, Oregon, of the $\frac{1}{4}$ interest in the property formerly held by the estate of the late Damian Cardoner of Barcelona, Spain. With the exception of August Paulsen of Spokane, Mrs. Boyce becomes the largest individual owner in the Hercules mine, her interest now being 7/32, while the Paulsen interest is 33/128, or a fraction over one-quarter. The aggregate interests of the Days in the Hercules now amount to 33/64, or slightly more than a half. The Days are divided into 3/32 each for Harry L., Jerome J., and Eugene R. Day, while Blanche Day Ellis, a sister, holds 1/64. The consideration named in the deed, which bears date of October 28, is \$1, but it is believed that the price actually paid is \$500,000. The $\frac{1}{4}$ interest conveyed by deed is the interest left in the estate of Cardoner, and was appraised in probate court at \$250,000. This interest was distributed to Mathilde Cardoner, widow, and the deed is made by her to Mrs. Boyce.

FLORENCE. In the Marshall Lake district, 40 miles southwest, W. Fox and two others cleaned-up \$20,000 from a 7 days' run with a Chilean mill. Ore containing \$400,000 is said to be blocked out in the Sherman property.

KELLOGG. Rapid progress in construction is reported at the Bunker Hill & Sullivan smelter. An average of 275 men is employed on the buildings, stack, etc.

KINGSTON. After an examination of the Hypotheek mine had been made by its representatives, the Rex Consolidated Mining Co. has taken a tentative option, according to rumors circulating both in Spokane and the Coeur d'Alene. The engineers' reports have not yet reached New York, however, and there is no definite assurance that the Rex directors will authorize the purchase. The Hypotheek was equipped recently with a 200-ton daily capacity concentrator and machine-drills. Regular shipments are being made to the smelter at Northport, Washington. The crushing department of the concentrator is capable of dealing with 500 to 600 tons of ore daily. The Rex company has purchased 6 claims adjoining the Rex group in the Nine-Mile district, for \$47,600 cash and 187,000 Rex shares.

MULLEN. Capacity of the Gold Hunter company's concentrator is to be increased, and the apparatus remodeled to treat the lead and silver ores. During its last financial year the output was \$614,590 from 118,764 tons of ore, yielding a profit of \$31,662.

PIKE CREEK DISTRICT. The Highland-Surprise company will practically double its milling capacity and as soon as improvements now under way are completed, thirty additional miners will be employed, according to W. W. Papesch, the president. Another cell is to be added to the flotation-plant, and the present small crushers and rolls are being replaced by 40-in. rolls and crushers of double the former size. This will give the mill a capacity of from 150 to 175 tons daily. These changes will be complete in about 10 days. Physical condition of the mine shows an immense quantity of ore blocked out for shipment. The Highland orebody is being opened for a length of 480 ft. with a vertical depth of 440 ft. Stopping is under way on this body, which shows ore at both ends of the drift from 2½ to 12 ft. in width, and carrying 14% zinc, 8% lead, and 5 oz. silver per ton. The management expects to ship not less than 50 tons of concentrate per day as soon as the improvements are completed.

Recently on the 200 and 400-ft. levels of the Northern Light mine three veins have been developed, exposing a large tonnage of lead, zinc, and copper ore, including some silver. A recent cross-cut at 400 ft. has passed through 25 ft. of ore, 5 ft. of which is solid lead-zinc ore. An average sample yielded 7.5% lead, 9.5% zinc, and 20 oz. silver per ton. B. G. Harmon is in charge.

WALLACE. The Montana Power Co. has connected up its high-tension power-lines with the Coeur d'Alene region, and has begun to serve the Douglas and other mines.

MICHIGAN

Houghton. During the latter part of November three steamers carried to lower lake ports over 3000 tons of refined copper each. The season for navigation is nearly over. More metal was moved on the Lakes this season than before.

The labor situation in the Lake Superior mining district has cleared itself in a remarkable manner, according to the *Daily Mining Gazette*. The number of men employed increases steadily now that winter is ahead, and the men are doing more work. That applies particularly to contract mining and tramming where the pay is high. Ten years ago it was proposed to eliminate contract mining—the old Cornish mining system that came to the Lake Superior district with the first copper miners. Some of the companies applied nothing but the day-wage system to all miners, but in recent years more and more of them have changed back to the contract system. When the Calumet & Hecla took over the Fay and the Bigelow mines they instituted the contract system, always popular in the C. & H. And it has resulted in greater efficiency. At the present time the men are making larger wages. Miners who are able to get better than \$200 a month are not so exceptional as formerly. This is not the average, of course, but there is hardly a contract miner in the district who is not averaging over \$5 a shift at present. Of course the contract men are the best men. And they work all the time and know their business. They are the pick of the miners. Contract tramming, at first considered a joke, is becoming more and more in vogue, and it is resulting in a much larger haulage per ton than ever considered possible. Not only that, but the men are making a great deal more money than was possible on the first scale. One gang of trammers averaged \$4.85 per shift, per man, in October.

MISSOURI

Joplin. Best grades of zinc ore advanced \$10 per ton last week, the range being \$90 to \$105. Lead and calamine were also higher. The output of the Missouri-Kansas-Oklahoma region was 8202 tons of blende, 1023 tons of calamine, and 1129 tons of lead, averaging \$95, \$54, and \$87 per ton, respectively. The total value was \$937,187, and for 47 weeks, \$30,381,854.

Owing to curtailment of work in this district, and many men going to the busier Oklahoma centres, there is a shortage of shovelers at Joplin.

MONTANA

Bannack. As the Bannack Gold Mining Co. could not get delivery on its order for a Diesel engine it will not be possible to start the new 150-ton mill. The climate is too severe to depend on water-power during the winter.

Butte. During October the Butte & Superior treated 51,450 tons of ore assaying 15.52% of zinc. The recovery was 92.5%. Zinc in concentrate totaled 15,691,000 pounds.

In the suit of Minerals Separation v. Butte & Superior, Judge G. M. Bourquin decided that the defendant is not to be restrained from paying dividends, disposing of assets, or enlarging its plant. The company was also released from the bond of \$75,000 to secure a possible judgement for infringement of the M. S. patent. The crushing plant is to be enlarged at once.

Iron Mountain. Owing to a freeze-up and shutting-down of mine and mill the Intermountain Copper company was unable to distribute its second dividend of \$8075.

Troy. If all is complete it is expected that the Snowstorm Consolidated mill will commence operations early in January. L. Greenough is general manager. Over 700 men are employed at present.

NEVADA

(Special Correspondence.)—A smelting plant of 150 tons' capacity is being erected at the copper centre of Bullion, 28

miles south of Elko, by T. M. Moe and associates. The plant is scheduled to go into operation before the end of December. Coke and crude oil will be used as fuel. The company has acquired large dumps of medium-grade ore, and in addition will take the output of leasing companies, of which nine are shipping at present.

The Hidden Treasure group of gold-silver-lead claims has been taken under bond and option by W. D. Chambers and associates of San Francisco, and work started with a few men. The property is about 1½ miles from Aura, and is owned by R. S. Carmichael and William Vore of Elko. Approximately 1200 ft. of development has been done, and a large quantity of ore exposed.

Elko, November 25.

(Special Correspondence.)—The Nevada Consolidated is working at full capacity in all departments. At the mines four or five cars of silicious carbonate ore, mostly from the stock-pile, saved in removing the overburden, is shipped daily to Garfield, Utah. This ore is said to contain 4 to 6% copper. Some comes from open-cuts. This silicious ore is used all the time in the converters at McGill, three or four cars per week. Work on the larger crushing-plant is being hurried, but on account of non-delivery of material the completion will be delayed into next year. The public appears to have finally found out, during the past three months, judging from the number of sales, and activity of the shares, to realize that it has been the cheapest stock of all the coppers. Outside of the known drilled 50,000,000 tons, the company has a large area of as promising ground as that which has been opened. Drilling operations this year have developed other extensive deposits. The metal extraction at McGill is the best of any of the large coppers. Inspiration, in Arizona, shows higher, but they deduct from the heads first the carbonate content.

At the old Giroux the Coppermines Consolidated is sinking the Morris shaft at a cost of upwards of \$250 per foot, according to those in a position to know. The mill will be completed ahead of contract time if the company is able to secure the materials.

Active work is being pushed at the Ward mine, 18 miles south of Ely, both on account of those holding the bond and lease and those having a lease on the workings.—A couple of men are at work on the Argus, across the valley from Ward. W. Stewart, on the Minerva Tungsten, south of Osceola, is employing three men. The U. S. Tungsten Co. has a few lessees extracting ore.

North in Spring valley, R. Millicek has commenced operating the mill on the Piernont property; the plant was moved from south of Cherry creek. Some Salt Lake City people are working the Grand deposit, at Muncy creek, near Aurum, and are now hauling one carload of copper ore to the smelter at McGill. The Utah people who have been doing some work on the Lucky deposit, at the old town of Aurum, have quit.

The Tungstania Mining Co. is running its mill continuously. The owners have an extensive deposit of commercial ore and with better milling facilities this should prove a winner, at one-half the present price of concentrate. Utah people are erecting a small mill at Miles spring, three miles west of Tungstania, to treat tungsten ores, which they have north and west of Tungstania.

Lacey and Clarey are working their Red Hills lead-silver mine. Their dead work, a long cross-cut tunnel and raise, is nearly finished, when they should be able to make shipments.

There is more activity than in many years and ores are being shipped from the old camp of Hamilton, 45 miles west of Ely.

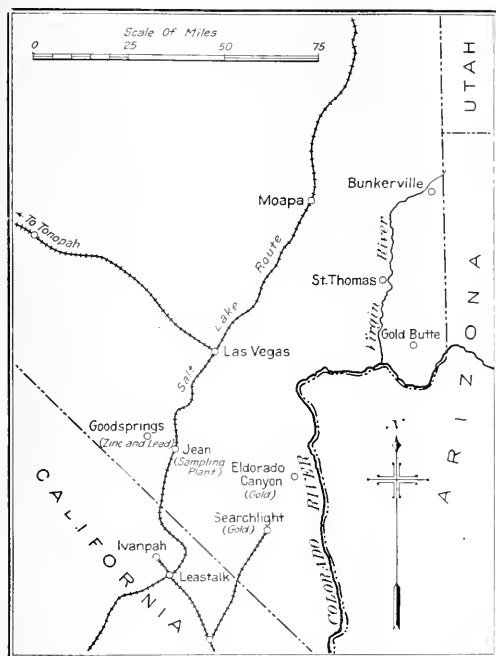
Paul Moorman has just shipped another car of silver-lead ore, that assays \$100 per ton.

Ely, November 20.

Goldfield. Final figures for October show that the Goldfield Consolidated made \$17,016 net from 30,000 tons of ore treated.

Costs totaled \$4.78 per ton. Filter and flotation royalties were 4c. per ton each. Development cost \$5.65 per foot for 1896 ft. It is expected that one 500-ton flotation unit will be ready early in January.

GOODSPRINGS. To receive ore from this zinc-lead centre and



MAP OF SOUTH-EASTERN NEVADA.

other districts, Utah people are to erect a sampling-plant at Jean to handle 200 tons in 10 hours.

TONOPAH. During October the Belmont made a profit of \$90,872 from the treatment of 12,367 tons of ore. The Extension's profit was \$50,902 from 10,038 tons. This company will pay dividends of 3% and 10% on January 1.

(Special Correspondence.)—Good progress is being made in, unwatering the deep winze near the Mexican-Ophir line. The 2700-ft. level is now open and changes are being made in the 3-compartment winze. The two dividers are being removed, and a single centre-piece is being substituted, giving the winze two compartments instead of three. This is necessary to make room for the handling of the electric pump which is being lowered as the water goes down. It is expected that the 2900-ft. level will have been reached by the middle of December, when extensive prospecting work on that level will be commenced by cross-cutting both east and west at various points from the long level run by W. H. Patton many years ago. A valuable shoot of ore was discovered some time since, back on the foot-wall in the Mexican, from which over \$400,000 has already been taken. Most of the ore from the Mexican in recent years has been mined in the hanging-wall ground which has resulted in the production of several million dollars from this series of orebodies in the Mexican and Union mines.

Virginia City, November 29.

During its financial year the Union Con. Mining Co. sent to the Mexican mill 16,126 tons of ore averaging \$25.86 per ton. The profit was \$262,057. Owing to the plant being short of cyanide, ore is now being stored. The Union shaft was re-

opened from 2000 to 2500 ft. This improved ventilation and operations considerably. Exploration is under way at 2300, 2400, 2500, 2600, and 2700 ft. When the 2900-ft. level is dry a large area will be available for prospecting. Whitman Symmes is superintendent.

YERINGTON. During the third quarter of 1916 the Nevada-Douglas Consolidated Copper Co.'s revenue totaled \$146,002 from the sale of ore and precipitate. The net profit was \$60,827, after paying operating expenses, interest, bonds, etc.

NEW MEXICO

(Special Correspondence.)—The Socorro M. & M. Co.'s product for the first half of November was 18 bars of gold-bullion. —The Mogollon Mines Co.'s clean-up for the same period yielded 820 lb. of bullion and 21 tons of high-grade concentrate, from 2000 tons of ore. The new 960-ft. shaft has been timbered 700 ft., and is said to be the best work done here. Timbering will be extended to the bottom as rapidly as possible.

The Oaks Co. is making another shipment of ore to custom mill.

At the Pacific mine, the ore-bins are being filled and aerial tramway to the Socorro mill will be started this week, and regular daily shipments maintained. A test run of the tram was entirely satisfactory.

(Special Correspondence.)—The road through Mogollon is being macadamized and repaired to accommodate heavy traffic without inconvenience in winter.

D. E. Bearup, owner and operator of the Eureka mine in which a rich discovery was recently made, is scouring the place for burros to pack an accumulation of milling ore to the local custom works. The richer ore is being sacked for shipment to smelter.

Timbering of the new shaft below the 500-ft. level in the Last Chance mine is progressing rapidly, the work being conducted from two different points. The shaft is 960 ft. deep. Development will be pushed from both the 800 and 900-ft. levels as soon as timbering will permit. The Mogollon Mines Co. is operating the property.

The Socorro M. & M. Co. has installed an automatic scale at the mill terminal of the aerial wire-rope tramway from the Pacific mine for weighing all ore received from the latter property. A belt-conveyor is being erected to handle this ore between receiving bins and crusher.

The Oaks company is breaking ground in its main drainage and transportation tunnel on Mineral creek, which will eventually open the main vein systems of the district at various depths up to 1800 ft. A road to the tunnel-site has been overhauled to facilitate traffic to that point. —At the Eberle mine, drifts are being advanced both north and south from the 50-ft. level in an exploratory shaft, which is equipped with a Fairbanks-Morse 15-hp. gasoline hoist and compressor plant. —Present development on the Clifton mine consists of driving the south drift from the adit-level and raising on No. 1 orebody.

Mogollon, November 20.

TYRONE. Renewed activity is reported from the old Black Hawk silver district of Grant county. Under E. D. Lidstone the Black Hawk mine is being unwatered and re-timbered to 750 ft. Work is also under way at the Extension, Black Jack, and Rose mines.

OKLAHOMA

CARDIN. At the Bilharz company's mine the new 400-ton mill, costing \$60,000, is in operation. F. H. Gartung is manager. The machinery is driven by 150 and 50-hp. motors. Mining is done at a depth of 270 ft. The zinc and lead ores are of high quality.

By the middle of December a new 250-ton mill will be at work on the ground of the W. M. Sheridan Trustee Mining Co.,

in charge of J. W. Marshall. Prospects for a good future are considered splendid.

UTAH

ALTA. The Alta T. & T. Co.'s tunnel is considered to be near the vein, as the formation is mineralized and the flow of water is increasing.

SALT LAKE CITY. After the return of O. C. Ralston to this city from a tour of investigation in several states, the U. S. Bureau of Mines issued the following notes:

At Pueblo, Colorado, there is a zinc smelter which is the only one in the country operating on a zinc-lead basis. The zinc in complex ores of this type is first distilled, and the residue is then sent to lead blast-furnaces for extraction of the lead, silver, and gold. As far as could be learned, most of the zinc, lead, silver, and gold-contents in such ores are being recovered in this plant, but the present ore-buying conditions are such that a smelter pays for only 60% of the lead in a zinc ore, and at a figure considerably below the market value of the lead, and the same is true of silver. In fact, the present metallurgical margin between the value of the metals in such complex ores, and the price usually paid for them is so large that many people are considering entering the field of treatment of complex ores. Throughout south-west and central Colorado are numerous deposits of these complex ores, most of which are not being worked, as the total cost of smelting is at present so high as to make it almost prohibitive to treat the ores.—In New Mexico the magnetic-separation plants at Kelly, Silver City, and Hanover were visited. Each of these plants is in the complex-ore district, and is making zinc or zinc-lead products from ores contaminated with iron sulphide. The magnetic concentration plants are removing the iron from such ores. It was learned that such large losses of ore were sustained in these plants from dusting, etc., that as a rule 1 lb. of zinc is lost for every 2 lb. shipped from the mill in a concentrate. On that account methods of treatment of such ore yielding higher recoveries of the zinc should be developed and used. Plans are now on foot for doing this.—At Bisbee, Arizona, it was found that while this mining centre is reputed to be a producer of copper, it is now developing large quantities of lead and zinc ores. Lead carbonate ores, which are difficult to concentrate, are present in many of the copper mines, and are being exploited in only a few instances. As the Salt Lake City experiment station has developed three alternative methods of treatment of such ore during the study of Utah problems, it has been easy to get out an immediate solution of the difficulties in this district. The Shattuck-Arizona company has employed as metallurgist Glenn L. Allen, formerly one of the 'fellows' of the department of metallurgical research at the Salt Lake City station. It is further learned that in the Junction mine of this district a large body of complex sulphides of lead, zinc, and iron has been developed. These are very similar to the Colorado complex ores.—In the Chloride-Kingman district of Arizona considerable activity is now evident in the mining of complex ores, and throughout Arizona at various places are locations where this type of ore is being developed.—At Los Angeles, Mr. Ralston visited the plant of the Stebbins Dry Concentrator Co. In many of the Inter-mountain mining districts not enough water is available for milling purposes, and it has been found that many of the lead and zinc ores of lower grade are not being concentrated, due to this deficiency, hence a study of the various methods of dry concentration will some time be taken up by the Salt Lake station. The plant of the Western Precipitation Co. at Los Angeles was also visited, and samples of some strange products from testing by flotation were obtained. This company is exploiting the Cottrell precipitation process and in passing petroleum and other oil vapors through a Cottrell treater, some strange new products were obtained which promise to be good frothers for flotation work.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

I. D. D. DAIMPRÉ is with the Army Medical Corps in France.

E. C. MORSE has returned from Dolomi, Alaska, to Portland, Oregon.

L. J. PEPPERBERG has gone to Salt Lake City, to be absent several weeks.

F. L. SIZER has returned to Butte from a visit to the Coeur d'Alene, Idaho.

THEODORE J. HOOVER has opened an office in the Mills building, San Francisco.

J. H. BATCHELLER is manager for the Virginia Lead & Zinc Corporation, in Virginia.

EDWIN HIGGINS recently was appointed consulting engineer of the U. S. Bureau of Mines.

WILLIAM HAGUE has opened an office, as consulting engineer, in the Mills building, San Francisco.

W. ROWLAND COX has been inspecting the Socorro Mining & Milling Co.'s property at Mogollon, New Mexico.

SAMUEL COLT, superintendent of the Princeton Mining Co., at Dolomi, Alaska, has returned to Nevada City, California.

HENRY G. FERGUSON, of the U. S. Geological Survey, has just finished a complete geological survey of the Mogollon district, New Mexico.

C. C. BURGER, who was partly instrumental in the formation of the Andes Copper Co. of the Anaconda company, has sold his interest therein and has resumed professional practice at 71 Broadway, New York.

FRANCIS A. THOMPSON, head of the department of mining engineering at the State College of Washington, has recently been engaged in making an exhaustive examination of quartz properties near Pierce City, Idaho, for New York interests.

FREDERICK LAIST, formerly metallurgical manager, has been promoted to be manager of the Washoe Reduction Works at Anaconda, in place of E. P. MATHEWS, who resigned to go to Canada. C. A. LEMMON, formerly civil engineer for the Butte, Anaconda & Pacific Railway, has been appointed assistant manager under Mr. Laist, and will have charge of all operations of the Anaconda company, at Anaconda, exclusive of those conducted at the Reduction Works and foundry department. In that capacity, Mr. Lemmon will have supervision over all sociological, or welfare work, with which the company is connected.

Obituary

The death of SAMUEL JAMES is announced by the Northport Smelting & Refining Co. Mr. James was manager of the Northport company and is succeeded temporarily by R. W. Marston.

GEORGE NELSON WAGONER, well known in Nevada county, California, died recently at Boma, in the Belgian Congo, at the age of 28. He had been in the employ of an English syndicate in Africa for two years.

GEORGE W. McDANIEL, Stanford '08, died on November 21 of typhoid fever at the age of 31. He had been employed by J. E. Spurr as field engineer on mine exploration and examination work in the United States and Mexico; and by the Tonopah Mining Co. in the United States, Mexico, Alaska, and Canada. He had superintended properties in Nevada and Colorado. At the time of his death he was engineer for the Tonopah Mining Co. at Tonopah, Nevada. He is survived by a wife and son.

THE METAL MARKET

METAL PRICES

San Francisco, December 5.

Antimony, cents per pound	14
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.25-8.50
Platinum: soft and hard metal, per ounce	105-111
Quicksilver, per flask of 75 lb.	\$80
Spelter, cents per pound	13
Tin, cents per pound	45
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, December 5.

Antimony: 50% metal, per unit	\$1.00
Chrome: 40% and over, f.o.b. cars California, per ton	15.00
Magnetite, crude, per ton	6.50-9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO ₃ , per unit	17.50-20.00

At Boulder, Colorado, there has been bidding for tungsten ore, and an advance in price is expected.

New York, November 29.

Antimony: Only a small business has been done in antimony ore. The quotation is unchanged at \$1.50 per unit.

Molybdenite: The market is unchanged at \$1.75 to \$1.85 per lb. of MoS₃ contained.

Tungsten: Europe has a good buyer, taking 100 tons and bidding for 100 tons additional. Altogether the market has been active, and most of the ore available for prompt delivery has been absorbed. The quotation is \$18 per unit, with \$20 expected before the end of the year.

EASTERN METAL MARKET

(By wire from New York.)

December 5.—Copper is strong, with the future demand steady; lead is also strong, though irregular; spelter is easier from profit-taking.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Nov. 29.....	34.00
" 30 Holiday.....	34.00
Dec. 1.....	34.00
" 2.....	34.00
" 3 Sunday.....	34.00
" 4.....	34.50
" 5.....	34.10

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26
Feb.	14.46	14.38	26.62	Aug.	12.34
"	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.02	Oct.	11.19
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.47	Dec.	12.75

Wages at Butte have been raised 25c. per day, to \$4.75, from December 1, to remain so as long as copper sells for 27½c. or over. About 20,000 men benefit, including those of the zinc mines.

October output of Utah Copper was 20,225,529 lb.; Chino, 6,921,081; Nevada Con., 8,676,327; and Ray Con., 7,590,038 pounds.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Nov. 29.....	74.37
" 30 Holiday.....	75.12
Dec. 1.....	75.25
" 2.....	75.25
" 3 Sunday.....	75.00
" 4.....	75.50
" 5.....	75.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90
Feb.	57.53	48.45	56.74	Aug.	54.25
"	58.01	50.61	57.89	Sept.	53.75
Apr.	58.52	50.25	64.37	Oct.	51.12
May	58.21	49.87	74.27	Nov.	49.12
June	56.43	49.03	65.94	Dec.	49.27

The silver market shows considerable strength, exchanges in China being firm and the export season is in full swing. India

has competed for supplies, and the European coinage demand is steady.

All the Mints in the United States are working full time making small silver coins.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Nov. 29.....	7.25
" 30 Holiday.....	7.25
Dec. 1.....	7.25
" 2.....	7.25
" 3 Sunday.....	7.37
" 4.....	7.50
" 5.....	7.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
"	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.80
May	3.90	4.21	7.38	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

Bunker Hill & Sullivan paid two dividends of \$81,750 each on December 4. This makes a total of \$18,489,750 to date. The Caledonia company, under the same management, paid \$78,150. Consolidated Mining & Smelting Co. of Canada distributes \$250,000 on January 2, making \$881,204 for 1916.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Nov. 29.....	13.25
" 30 Holiday.....	13.25
Dec. 1.....	13.25
" 2.....	13.25
" 3 Sunday.....	13.25
" 4.....	13.25
" 5.....	13.25

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
"	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	16.01	Nov.	5.01
June	4.84	22.20	12.85	Dec.	5.40

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Nov. 21.....	80.00
Nov. 7.....	80.00	80.00
" 14.....	80.00	80.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50
Feb.	39.00	60.00	235.00	Aug.	30.00
"	39.00	78.00	219.00	Sept.	36.25
Apr.	38.90	77.50	141.60	Oct.	33.00
May	39.00	75.00	90.00	Nov.	35.00
June	38.60	80.00	74.70	Dec.	33.10

TIN

Prices in New York, in cents per pound.

Date	Average week ending
Nov. 29.....	74.37
" 30 Holiday.....	75.12
Dec. 1.....	75.25
" 2.....	75.25
" 3 Sunday.....	75.00
" 4.....	75.50
" 5.....	75.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60
Feb.	39.76	37.23	42.60	Aug.	30.20
"	38.10	48.76	50.50	Sept.	33.10
Apr.	36.10	48.25	51.19	Oct.	30.10
May	35.29	29.28	49.10	Nov.	33.51
June	30.72	40.26	42.07	Dec.	33.60

Tin is steady at 45 cents.

ANTIMONY

This metal is quiet, but firm, at 14.50c., duty paid, for Asiatic grades at New York.

ALUMINUM

The market is a little easier at 63 to 65c. for No. 1 virgin aluminum, 98 to 99½ pure.

Eastern Metal Market

New York, November 29.

That the copper market is quieter is admitted on all sides, but prices are practically as strong as ever. The large production, and possibility of metal being re-sold, and that shipments may be delayed is causing some apprehension, the latter for the reason that it is deliveries and not sales that actually count.

Zinc has been active and quotations are higher, although the upward trend has been halted slightly by the tendency of second-hands to take profits. Sheet zinc is now quoted at 21 cents.

Prompt lead is scarce. The leading producer is not selling at its official quotation, but is taking some January business at 7.15c., New York. Independents are well sold-up, but have made contracts at 7.25 to 7.30c., New York. Higher prices are looked for.

The week has been quiet in the tin market.

Antimony is dull but firm.

Aluminum is a trifle easier.

Excitement continues the feature in the pig-iron market, both foundry and steel-making grades advancing by leaps and bounds. Since the first of November, prices on some grades have shot-up as much as \$8 per ton. Buffalo No. 2X has sold at \$30 per ton at furnace; eastern Pennsylvania No. 2X has sold at \$29, furnace, and Southern iron at \$23, Birmingham. Basic has sold at \$30 valley (Pittsburg), and Bessemer at \$33 for standard grades, and \$35 for special. Standard low phosphorus is quoted at \$49 to \$50, delivered. The export demand is tremendous and almost entirely responsible for the situation.

The demand from both the Atlantic and Pacific coasts for ship-plates is overwhelming the mills, and sales at 5c. per lb. for the last half of next year have been made. Advances in prices are too numerous to mention *in extenso*. Wire products have gone up \$2 per ton. Steel rails are being bought for 1918 delivery at \$10 over the price paid for 1917 delivery. Re-rolling billets are quoted at \$55 per ton and forging billets at \$75 upward. The entire situation is amazing.

Revised ore prices are as follows: \$5.95 for old range and \$5.70 for Mesabi Bessemer; \$5.20 for old range and \$5.05 for Mesabi non-Bessemer. The advance amounts to \$1.50 per ton. It was expected to be but \$1.30, but this was changed by an advance in wages granted to the iron-ore miners.

COPPER

The demand for copper is easier, as should be expected after the heavy and excited buying of recent weeks. At the same time, quotations are about as strong as ever. When concessions are made they are a consequence of quiet negotiations of which the public is supposed to know nothing. Of course, there is more or less current business, and if copper were more plentiful for near-by delivery more would be doing. An Italian interest is understood to have taken a large block within the past week. Prompt, December and January metal, both Lake and electrolytic, is held at 31c. For most positions the range of quotations is unusually wide. Some sellers quote December at 34.50c., first quarter at 33.75c., second at 33c., third at 31.75c., and last quarter at 31c. On the other hand, others say that the producers are covering favored customers at 33c. for the first quarter, and that on quiet transactions 32c. probably could be done for second quarter and 31c. for third quarter. It is intimated that some of the consumers who have withheld from covering their second-quarter requirements may profit thereby. Last week allusion was made to the uneasiness with which the trade was viewing the course of prices, and conservative members continue to express similar views. They point out that, in the last analysis,

it is not sales, but deliveries, that count, and should deliveries be interfered with, re-sale metal might well be expected to appear. Last winter, when the mills in New England were embargoed, considerable copper was thrown on the market with a depressing effect on prices. Already many Eastern freight-terminals are congested, and New England has been embargoed. Again, there is the probability of speculators, and even consumers, selling metal to take the handsome profits that they can realize. A note of caution, inspired by production figures, is sounded by 'Copper Gossip,' the organ of the National Conduit & Cable Company.

The demand for brass and copper products shows no sign of letting-up, and for prompt shipments premiums are cheerfully paid. It is asserted by a mill rolling sheet copper that it cannot compete with English mills, despite the scarcity of copper abroad and the great demand for finished products. Sheet copper is quoted at 42c., mill. The London market for spot electrolytic is stronger, the quotation yesterday being £169 against £163 a week previous. Exports, November 1 to 28, totaled 19,622 tons, a rather small showing.

ZINC

Business has been good in the past few days, although on Monday and Tuesday of this week a somewhat easier tendency developed through the desire of second-hands to take profits. They offered and sold zinc at prices a little below the quotations of the producers. The latter are not so willing to sell far ahead as they were. All classes of consumers have been in the market. Prompt prime Western was to be had yesterday at 13.25c., New York, and 13c., St. Louis, although some of the producers were asking at least 1c. over these prices. For December producers wanted 13.12½c., St. Louis, for first quarter 12.87½ to 12c., and for second quarter 12 to 12.25c., St. Louis. On the other hand, dealers quoted first quarter at 12.75c., St. Louis, and 12c. for second quarter. Prominent producers believe that prices will hold fairly firm throughout the winter. The London market for spot was quoted yesterday at £59 against £56 10s. a week previous. Exports, November 1 to 28, were large, amounting to 13,334 tons. Sheet zinc for prompt shipment in carload lots is quoted at 21c., f.o.b. smelter, 8% off for cash.

LEAD

The lead situation is an interesting one for several reasons. In the first place, while the A. S. & R. Co. has not changed its official quotation of 7c., New York, and 6.92½c., St. Louis, it is nevertheless taking orders for January shipment at 7.15c. Near-by lead is difficult to procure. The independent producers are well filled with orders, and when they sell, their product easily commands 7.25 to 7.30c., New York. The leading interest is not selling prompt metal, and probably will not until its price is advanced. The trade will not be surprised to see the quotation go to 7.50c. in the next few days. There is a good demand, as yet unsatisfied. The London spot quotation is unchanged at £30 10s. Exports November 1 to 28 totaled 1363 tons.

TIN

The quotation for spot Straits tin yesterday was 45.25c., New York. In the week the price has been higher, but the market became easier as dullness became more settled. The only interest shown was in far futures. One explanation of the quiet is that the tin-plate mills only cover their contracts when the latter are signed and sealed, in a manner similar to that in which the brass mills have been buying copper and spelter. The statistics are considered fairly good, the arrivals this month amounting to 2320 tons, while there is afloat 2392 tons.

Book Reviews

FIELD GEOLOGY. By Frederick H. Lahee. P. 508. Ill., index. McGraw-Hill Book Co., Inc., New York, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price \$3.

The author presents an excellent treatise on geology which will be useful to students and engineers in the field, its size 7.5 by 5.25 in. with flexible morocco cover, making it convenient to carry in the pocket. It contains 409 half-tones and line-drawings, which so illustrate the text that even the young student can understand. In addition to the descriptive geology there is a chapter devoted to geologic surveying, in which many valuable suggestions are made to the young geologist and engineer in the field. Another chapter deals with the preparation of reports and geologic maps, and in the appendix are found tables for use in determining rocks; the solution of triangles, and a useful bibliography. In fact, it covers the field thoroughly, from the viewpoint of both the geologist and the engineer.

THE MINES HANDBOOK AND COPPER HANDBOOK. By Walter Harvey Weed. P. 1686. Ill., index. Stevens Copper Handbook Co., 29 Broadway, New York, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$10.

Since 1914, when Volume XI was published, there has been a growing enquiry as to when the next edition would be available. The great business in copper is responsible for this demand for a reliable reference work. It is with pleasure that we review such a compilation, which must have occupied considerable time and labor. Compared with the previous number this contains 273 additional pages. As will be observed, the title has been changed, rendered necessary by the inclusion of companies extracting antimony, gold, lead, silver, tungsten, and zinc, in fact, all metals save iron, in addition to the usual details concerning copper companies. Herein lies the much-added value to the work, and for the first time those who use such a reference are able to find data concerning active companies producing all of these metals in North America, and a few in Central and South America. We have been accustomed in the past to consult Skinner's 'Mining Manual' for many things not answered in any American work; now we will find Weed's 'Mines Handbook' helps us considerably. Owing to the War, many foreign mines were omitted, as it was impossible to procure the required information. The data concerning individual companies range from one line to ten pages. The publication contains a vast amount of new matter, added to that in the last volume. In the first 22 pages the glossary of mining terms is right up to date, including definitions of flotation and froth. The increased search for the rarer and common metals has resulted in better study of their mineral occurrences, and in the Handbook are 24 pages giving all the copper minerals and the more important of the other metals, though we miss those of tungsten and molybdenum. From page 86 to 1249, inclusive, alphabetically arranged, are all the companies previously referred to. Statistics on the metal-mining industry cover 79 pages. Herein are production figures, prices, charts, brief notes on each important metal, and trading transactions. Chapters VII and VIII show dividends, prices of stocks, and data of the world's principal mines. A list of dormant or dead mining companies covers 97 pages. Chapter X is a directory of 175 pages of presidents, secretaries, treasurers, directors, mine managers, and superintendents of the companies listed. A geographical list of all companies occupies the last chapter. In short, a valuable compendium.

ACCIDENTS AT METALLURGICAL WORKS IN THE UNITED STATES is the title of Technical Paper 164 of the Bureau of Mines just issued.

Mining Decisions

OIL LEASE—LIABILITY TO PARTNERS

Persons contributing labor, material, and cash for driving an oil-well under agreement to incorporate and issue stock in proportion to their contributions if the well comes in, otherwise each to lose what he put in, are partners and are jointly liable for labor debts incurred by one of the partners in drilling.

Roberts v. McKinney (Texas), 187 Southwestern, 976. July 3, 1916.

COAL LANDS—NOTICE OF FRAUDULENT ENTRY

A coal company acquired a bond for a deed to a large quantity of land, 800 acres of which was then a part of the Public Domain and was known coal land. Subsequently the obligor obtained patents through dummy locators and conveyed the land to the company. Held, that the company was chargeable with knowledge of such facts that it was not entitled to protection as a bona-fide purchaser. The stockholders of a corporation which has purchased coal lands previously patented are not disqualified by such act from making individual entries of their own, as the acquisition by purchase after patent of coal lands is not counted as a "single entry" allowed by the statute.

Northern Colorado Coal Co. v. United States (Colorado), 234 Federal, 34. May 1, 1916.

OIL AND GAS LEASE—COVENANT BREACHED—DAMAGES

An oil and gas lessee who has assigned a portion of his interest in his leases and agreed with his assignee to pay all delay rentals until oil or gas is produced and who, although stipulating that he is not to be bound to make explanations, agrees that before he will suffer any leases to lapse, he will notify such assignee, and will assign to him all leases which he may not desire to keep alive, thereby impliedly covenants not to dispose of such leases to a stranger without the consent of such assignee. Such a covenant being personal would not pass with the lease on assignment to the new assignee. In estimating damages for breach of such covenant and subsequent lapse of the leases, it is proper to take into account the selling-value of the leases at the time the right of action accrued.

Millan v. Bartlett (West Virginia), 89 Southeastern, 711. September 12, 1916.

RAILROAD PATENT—COLLATERAL ATTACK BY MINERAL CLAIMANT

The plaintiff originally located mineral lands and mined ore thereon. Long prior to his location the land in question had been placed by Congress within the limits of a grant to the Central Pacific Railroad Co., and patent thereto was issued under the terms of said grant to defendant's predecessors in interest while the plaintiff was still in possession of and mining on said ground. Later the plaintiff abandoned his claim, and years afterward came back and re-located the land as a mining claim, on the theory that it had been excluded from the railroad patent as mineral-bearing land. Plaintiff's claim of title was based on this later location. Held, title vested in defendant under the railroad patent. The attempted exception from said patent by the Land Department of "all mineral land, should any such be found in the tracts aforesaid" was void on its face. The issuance by the Department of a railroad patent was in itself an adjudication that the land was non-mineral, conclusive against all collateral attacks. A subsequent locator is not in privity with the Government in the sense that would permit of a direct attack by him on the validity of the patent.

Vore v. Ephram (California), 159 Pacific, 719. August 2, 1916.

Industrial Notes

Information supplied by the manufacturers.

Pumping Water With Compressed Air

One of the most interesting air-lift plants in the South-west is the one on the J. A. White ranch, three miles north-west of Fort Bliss, near El Paso, Texas. One class N-SO Chicago pneumatic compressor pumps two wells, each 600 ft. deep, the water standing 250 ft. from the surface. The compressor forces the air down into the wells, and although they are not yet entirely free from sand, the water is raised in sufficient volume to supply a town of 2000 inhabitants.



PLANT FOR PUMPING WATER BY COMPRESSED AIR.

Class N-SO compressors are made in four standard strokes, 8, 10, 12, and 14 in., with capacities from 70 to 300 cu. ft. They may be supplied portable (on truck) or skid mounted as well as stationary, and are manufactured by the Chicago Pneumatic Tool Company.

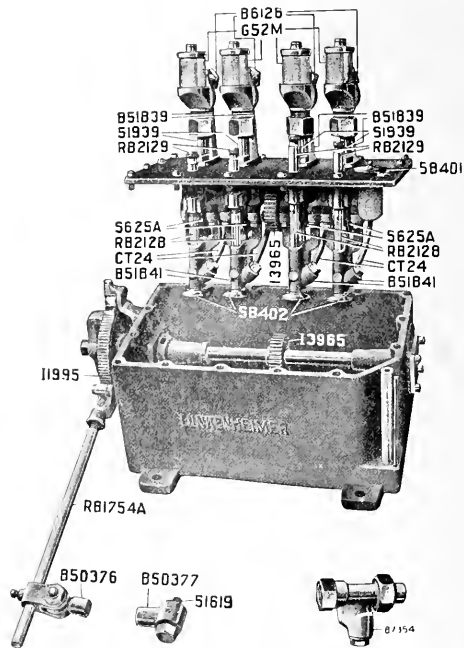
New Type of Mechanical Oil-Pump

The oil-pump shown was designed for the lubrication of stationary and portable steam or Diesel oil-engines and air-compressor cylinders. The manufacturers, the Lunkensheimer Co. of Cincinnati, Ohio, exercised great care in the selection of the materials used in the construction of the pump. As practically all operating parts are within the body and either immersed in oil or automatically lubricated, the greatest durability possible is attained.

The operation is as follows, reference being had to the accompanying illustration: Engine-link B-50377 is attached to eccentric rod or other moving part of engine and connected to link B-50376 by a rod of proper length. Line check B-7354, threaded for 1-in. pipe, is furnished for every oil outlet on pump and is attached as close to the steam pipe as possible. The position of the link B-50376 on rod RB-1754A, governs the arc of travel of ratchet-wheel I-1995. Gear I-3965, revolving with ratchet-wheel I-1995, imparts motion to pump-plungers through the mediums of gear I-3965 on eccentric shaft and eccentrics S-625A. Auxiliary plungers being suitably connected with force-pump plungers, move in unison therewith. On the up-stroke of auxiliary plungers, oil is drawn through strainers in bottom of holders SB-402, into auxiliary cylinders B-51841, from where it is forced on downward stroke through tubes CT-24, and passage in parts B-51829 to sight feeds G-52M. As the oil drops through the sight feeds, it is drawn into force-pump cylinder on the downward stroke of the plungers S-1939, from where it is forced upon the upward stroke through unions B-6126 to the cylinders to be lubricated. The quantity

of oil desired fed is regulated outside the body by auxiliary pump-plunger extension stems RB-2129. Regardless of the level of oil in reservoir, the lubrication of such parts within the body constantly requiring same, is automatically taken care of by an arrangement provided at the bottom of the force-pump plunger.

The pump operates only while the engine is running, and automatically feeds more or less oil according to the speed of the engine; consequently there is no waste of oil. Every outlet is provided with a sight-feed. These are large, will not



NEW TYPE OF OIL-PUMP.

become oil splashed, and the dropping oil can be plainly seen from a distance. Independent feed regulation for each outlet is also provided. They can readily be adjusted without the use of tools or the removal of any of the parts. The filling hole is large for convenience in filling. A sliding cap, to prevent dirt from entering, is provided, and within the opening is a bronze strainer which can readily be removed for cleaning. The pump can be had with from one to four feeds, the one-feed having a capacity of one quart or half-gallon, the two-feed, half-gallon or one gallon, and the three and four-feed, one gallon.

The trade name 'Invincible' has been given to the apparatus.

A 2000 ton mill is being erected at the Ray Hercules copper mine in Arizona, for which the DEISTER CONCENTRATOR Co. has been awarded a contract to supply 3 units of Overstrom tables of the latest type. This order consists of 4 roughers and 1 cleaner for each unit, or 15 in all.

Bulletin 201 of the ROLLER-SMITH Co. of New York briefly describes its portable storage-battery equipment for use with the firm's hand-tester on rails.

Bulletin 31 of the MINE & SMELTER SUPPLY Co. of Denver deals with the Lindsay oil-furnaces and burners, as used in assay-offices.

EDITORIAL

T. A. RICKARD, Editor

SPEAKING of patents, it is interesting to note that the Chilean law allows rights to anyone bringing forward a new application of another's patented invention.

SILVER continues strong at the pleasant price of about 75 cents per ounce. Prospects are good for the maintenance of a market favorable to the miner. Chinese exports are calling for silver in exchange and the European governments continue to buy silver for minting into subsidiary coin.

CURVES of the cost of living and of gold importation are found on opposite pages of *The Analyst*, suggesting the possible relation of cause and effect. The depreciation of gold, following upon our accumulation of a plethoric stock of it, is one reason why the cost of domestic supplies has risen so uncomfortably.

TENNESSEE COPPER has passed again into the hands of the Lewisohns, who first made it a success. A re-organization of the company has followed the resignation of Mr. Utley Wedge, who is followed, as president, by Mr. Adolph Lewisohn. We note, with pleasure, that Mr. J. Parke Channing also joins the board of directors.

REFERRING to the flotation decision, discussed on another page, it is necessary to note that the life of the basic patent, No. 835,120, is short. It will run as long as the British patent No. 7803, of which it is a duplicate. The latter dates from April 12, 1905, and has a life of 14 years, that is, to April 12, 1919, or a little over two years more. This is an important point that will become prominent in the discussion of the subject.

SECRETARY LANE'S annual report includes an account of the work done by the U. S. Bureau of Mines under the direction of Mr. Van H. Manning. The record includes sundry remarkable items, such as the extraction of \$1,000,000 worth of radium from carnotite ore mined in Colorado. During the year $8\frac{1}{2}$ grams of radium was produced at a cost of \$40,000 per gram, as compared with a market price of \$100,000. Most of this was delivered to the two principal cancer hospitals. Another important item is the claim that in the Rittman process the Bureau has perfected a cracking method for producing gasoline from crude oil at a cost of 6 cents per gallon. Controversy is rampant over this claim, but we hope that it may be fully confirmed in due course. The saving of \$20,000,000 worth of natural gas in the Blackwell district of Oklahoma and the development of an electrical furnace that will save \$10,000,000 in the brass industry

are two more feats recorded to the credit of the Bureau. Some of the newspaper summaries sent out from Washington savor of sensational advertising, and we regret that such methods should be deemed necessary to win public support for the Bureau. It is doing good work and needs no exaggerated stories to commend its labors to the special public interested in mining.

ON another page we publish a short but vivid account of the launching of another dredge on the property of the Yuba Consolidated Goldfields Company. This is written by Mr. Walter S. Weeks, of the University of California, and is delightfully illustrated with the photographs he himself took. Last week we quoted some of the figures of yield and cost at this celebrated gold-dredging mine, showing that the yield was 12.87 and the cost 3.7 cents during the first half of the current year. We are informed by Mr. W. P. Hammon that the type of boat described in the article will dig for $3\frac{1}{2}$ cents per cubic yard in the Yuba alluvium, where the depth of gravel below the water-line is 80 feet and the height of bank above water is 20 feet, so that the total depth of digging is 100 feet. A dredge of this kind will move boulders weighing four tons, but at Marysville the absence of any such masses of rock is a favorable feature, the largest weighing barely one ton. The power of the machine is shown, however, by its ability to knock off projecting points of rock, such as the basalt dikes protruding through the false bottom of tuff. Roots of trees and logs embedded in the gravel are the chief nuisance to the dredge-master, but even of these there is not much to interfere with regular excavation. The new dredge is almost a duplicate of its predecessor, the chief difference being the double stacker required to keep an open channel. Such improvements as have been made in the construction of this machine are mostly in the minor details that contribute to greater strength and to operation at a minimum cost, which means the overcoming of the liability to breakage and the consequent nearest approach to continuous running. The Yuba Consolidated is the biggest and best dredging enterprise in existence. There remains enough ground to operate for 12 years at the rate of 150,000,000 cubic yards per annum. The company is controlled in Boston.

IN this issue we publish another letter from our Mexican correspondent describing the real conditions prevailing in the interior of that ungoverned country. His description of the shifts to which Carranza has been put in order to raise money should prove illuminating. Re-

pudiation of one set of notes, bearing the seal of national honor, has been followed by the creation of new notes that within six months have fallen to the vanishing point. This destruction of paper-values has made it difficult for the *de facto*, more accurately the *pseudo*, government to satisfy the soldiers in its employ, so that discipline passes easily into desertion, setting loose a swarm of marauders. Cabrera's law regulating debts is worthy of *opera bouffe*. As is usual during a revolution, the debtor discards his obligations, so that the new decree is only an impudent legalization of accomplished depredation. The recent attempt to enforce payment in gold was a fiasco, of course, because there is not enough to go round, even if public confidence in the Government were such as to warrant the use of the hoarded coin in a world of flimsy paper. The banking position is as bad as it can be. Cabrera's baiting of the banks has only failed because the vaults are physically irresistible to anything except dynamite. From what our correspondent states, it appears likely that even explosive methods of finance will be adopted in the last resort. The Burton Wilson incident is significant as showing the difficulty of obtaining information without subjecting the informant to Mexican reprisals. If Cabrera and Carranza broke faith with the American members of the Commission, as is stated, it is high time to cease polite conversations with them. We believe the story told by our correspondent, who has proved singularly accurate in his previous letters. Famine and typhus are spreading over the devastated country. Zapata and his band are on the rampage still, Felix Diaz is somewhere on the edge of things concocting a new revolution, Villa is capturing cities and looting them as heretofore, Carranza is fulminating decrees and enacting paper laws, Washington is making phrases to pass the time of watchful waiting, and Mexico is sinking ever deeper into the abyss of perdition.

The Human Side of the Engineer's Work

We have received a short account of the Congress of Human Engineering that was held at the Ohio State University in the last week of October. This conference was designed to discuss the human factor in industry from various points of view, notably from the standpoint of the employer, superintendent, engineer, laborer, employment agent, welfare worker, economist, and teacher. All the students in the College of Engineering and in the Department of Economics and Sociology were required to attend, so that a considerable body of young men in the University of Ohio had the chance to learn something that should prove of great use to them. The various addresses delivered during the three days of session were intended to emphasize the fact that the engineer, in order to attain the highest usefulness to himself, to his employer, to the workmen, and to society as a whole, must be trained in a knowledge of the psychology, needs, possibilities, and weaknesses of the workers—in short, he

must do his share in bringing peace into industry, and to do that he must be equipped with a sympathetic knowledge of human nature. This conference appears to have achieved its purpose in bringing this point of view into large relief. The progress being made in social betterment throughout the country received proper recognition. Among the notable expressions of opinion we quote the following. Mr. W. A. Knight said: "Engineers are fast awakening to the fact that there can be no real efficiency in production without willing co-operation on the part of workmen." Mr. C. C. Morris: "The engineer of the future will be one with a more thorough training in the fundamentals, with a knowledge of men and things, and a sympathy broad enough to see even in the most illiterate immigrant not only a human being but a future American citizen." Mr. C. R. Dooley said that the meetings gave a "lasting impression that engineering is not altogether mathematics, and that human interest is not altogether sentimental." Mr. Charles R. Hook remarked: "Very little can be accomplished by any one individual in any industrial establishment entirely through his own efforts; it is his ability to obtain the co-operation of all those who work with him . . . that really counts." Mr. S. P. Brush acknowledged that "engineering courses are narrow to the extent that they deal only with things" and that "today the human element in all industry is of paramount importance." Finally, we quote Mr. F. H. Newell, who laid stress on the fact that "the full efficiency of any man, whether employer or employee, is the outcome of goodwill, of the proper mental attitude, such as is attained only when men have a close personal sympathy and a feeling that each is receiving the best which the conditions afford." He also said that "industrial or engineering success for any one man or class of men does not involve the corresponding distress of other men; but rather the contrary," and that "no working-man desires to be considered as an object of charity, but each has a proper right to demand equity." These sentiments do credit to the hearts as well as to the heads of the gentlemen quoted. They represent a composite opinion that it is a pleasure to record. Manifestly it is illogical to lay emphasis on the growth of the democratic ideal and then permit employers of labor to treat men that have become American citizens as if they were peons in the Mexico of today or serfs in the Russia of yesterday. It is equally foolish for engineers to talk about efficiency and then to spoil the usefulness of the chief implement of engineering—the worker—by handling him as if he were a bit of cotton-waste. And is it not also a blunder to prate about 'safety first' and then to treat so dangerous an explosive as collective bargaining as if it were a cylinder of sawdust? Is an engineer truly educated that regards labor organization as a nuisance to be tolerated or suppressed? These are some of the thoughts evoked by reading about this Congress of Human Engineering—we do not like the name of it, but it will serve. We do like the idea behind it, the intellectual sympathy that gave it momentum and that produced so fine an expression of opinion, for we

number ourselves with those that regard the labor problem as the most serious to be faced in this great industrial democracy. It is becoming more serious every year as the immigrant becomes Americanized into the rights and privileges of a citizen in a republic. The rise in wages caused by the War boom and the shortage of labor due to the check upon immigration are sure to be succeeded, when peace is declared in Europe, by a resumption of immigration and a drop in wages, inevitably inciting protests and strikes that will have to be met fairly and courageously. Mining will suffer from them, for a time, and engineers will have to play a part in adjusting them. They can do so, to the permanent advantage equally of those by whom they are employed and of those whom they employ, if they acquire a sympathetic knowledge of the conditions of labor, its rights and its responsibilities. The editor of an independent paper can sympathize with them—the engineers—because it is impossible to be just without antagonizing both parties in the eternal quarrel—a stupid quarrel—between capital and labor. We, for example, have never discussed a strike in a mining district without being anathematized by the labor-union and at the same time condemned by the company management. That, of course, is a compliment to our effort to be fair. So also the engineer, in his anxiety to be humane, may be reprimanded by the head-office, and in his desire to defend the rights of his employer he may be damned—or dynamited—by the men formerly under his direction. However, we see a great improvement. The more sagacious among presidents and managing directors realize the necessity for reasonableness—indeed many of them are leaders of enlightenment in this phase of human philosophy. The divine right of Baer and the anthracite trust is as much an exploded fallacy as the holiness of kingship. Nevertheless the engineer still occupies a middle position of much difficulty; it is a strong character that can escape on the one hand being made the tool of a soulless corporation and on the other hand becoming victim to an irresponsible conspiracy of walking delegates. It is in such a dilemma that the engineer proves himself educated in more than mathematics, versed in more than maxims, neither a pedant nor a brute, but a man and a citizen.

American Capital in British Columbia

In the course of a recent journey of observation through British Columbia, the present writer's attention was called to the fact that most of the important mining enterprises in the Province are controlled by American capital. It is true the Consolidated Mining & Smelting Company of Canada is a conspicuous exception, **but** the exception only serves to emphasize the general trend of affairs in that important mineral region. During the time of our visit the subject was brought to public notice in a speech by Mr. Lorne Campbell, the Minister of Mines, who had been attacked by the local

press of the opposite political party for his goodwill toward American operators. He replied that he was not concerned as to who developed the mines of the Province so long as they were developed. He recognized that the War had put a stop to the supply of money from England and suggested that capital for the purpose was not available just now in Canada. In the Sandon district, for example, out of 22 companies operating mines no less than 17 are backed by American capital, so said Mr. Campbell. He pointed to the fact that the principal mines of Rossland had been opened up by Americans, chiefly from Spokane and the Coeur d'Alene, and he spoke approvingly of the splendid work done by the Granby and Britannia companies, concerning which our readers can form their own opinion if they read the descriptive articles appearing in our pages. The Minister of Mines went further and expressed the hope that not only would American money become increasingly available for the development of the mines, but that capital from this side would be furnished for the erection of refineries in British Columbia, so that the base metals would not be exported to distant points in New York or Oklahoma. The blister copper made at Anyox, 550 miles northward from Vancouver, is sent to the Nichols refinery in the State of New York, 3300 miles eastward from Vancouver. During the past summer, matte made at Anyox has been shipped through Seattle across the border to Grand Forks to be converted, and the resulting blister copper then transported to New York. The copper concentrate from the Britannia mine is shipped to Tacoma. Zinc concentrate from the Kootenay region goes to Kansas City to be roasted for the manufacture of sulphuric acid, the residue after that operation being forwarded to Oklahoma, where it yields its zinc, and then to Norfolk, West Virginia, where finally the gold, silver, and copper are extracted. It is not surprising that the suggestion of establishing a refinery on the coast of British Columbia wins support, nor that American capital is invited to take the project in hand. From our own enquiries among representative Canadians, we ascertained that the Minister of Mines did not voice the opinion of any political party in this matter, but that the people of the Province generally are thoroughly in accord with the views enunciated by him.

Why should it be otherwise? Not only have Americans furnished the capital, but they have supplied technical talent of the highest order, so that mines heretofore unproductive have developed into centres of living industry. Many of the Americans employed at the mines and smelters have become naturalized, and all of them have proved good citizens in the country of their adoption—not of exile—at a time when the patriotic spirit of Canada has been thoroughly awakened by the great events in Europe. In short, the American in British Columbia is a welcome friend, not a foreigner. This is the consequence of their spirit of co-operation. They do not use their influence, as employers of labor, to corrupt the legislature or the municipality in order to gain special privileges; they simply behave as good citizens and

wide-awake developers of the mineral resources of the Province. That is a relation complimentary to the Dominion. In countries weakly governed it is difficult to do anything without being 'held up,' which, in the sequel, means compliance with methods of corruption. Canada is no so-called Latin-American republic ready to be the prey of an unscrupulous exploiter. The Government, both Federal and Provincial, may not be immaculate, but it offers no special temptation to alien corruption. In short, what is called the political 'penetration' of foreign capital and the commercial 'infiltration' of foreign interests in an insidiously disintegrating way is not possible in a country so well governed and so strong in its spirit of nationality as is Canada today. It is no Nicaragua, no Mexico, nor even Italy. Mr. Robert Herriek in his recent book, 'The World Decision,' tells how German capitalists got hold of hotels, the factories, the shops in Italy, and at the same time suborned the politicians, from Gioletti down. He also dwells upon the fact that much of Mexico's misery is traceable to the pernicious influence of foreign capital upon its domestic policies. On the other hand, the United States 'has drawn upon the European board as upon an international bank, but we have absolutely controlled the disposition of the moneys borrowed.' The beneficial exploitation of our own country by foreign capital has entailed no surrender of industrial or political power. The position of Canada is exactly the same. The peoples north and south of the unfortified international boundary go into the house of their friends with no thought of interfering with the domestic arrangements.

On the contrary, we see many reasons why the co-operation of capital and technical knowledge from the United States should be brought to bear on British Columbian mining enterprise. Our contiguity is convenient and attractive. This country is going to be a lender of money, instead of a borrower; the accumulation of capital in consequence of these years of abnormal prosperity is destined to create a surplus that will have to be used fruitfully. Why go to China and Peru, to Chile or Siberia, when a resourceful healthful mineral region is across the street, as it were? Why deal with people whose language we do not speak and whose ways of living we cannot understand if others between whom and us no such barriers exist are much nearer? A welcome is given by the people of British Columbia. They recognize that British, and even Eastern Canadian, capital is not going to be available in large amount, and being Western, progressive, and energetic, they turn naturally to the capable operators and engineers in our West for friendly assistance. We commend the matter to the consideration of our readers, believing that it will prove of mutual benefit to the two parties chiefly concerned. Those desiring information concerning the mining regulations, the distribution of the mineral deposits, the facilities of transport, and the like, should address themselves to the Provincial Mineralogist, Mr. William Fleet Robertson, at Victoria, to whose courtesy we can commend them confidently.

Minerals Separation Wins

On December 11 the Supreme Court of the United States, by unanimous decision, reversed the finding of the Court of Appeals in San Francisco in the case of Minerals Separation v. J. M. Hyde. The decision substantially affirms the opinion of Judge Bourquin in the District Court of Montana and upholds the validity of the basic patent, No. 835,120, owned by the Minerals Separation company, a British corporation. Thus the first phase of the flotation litigation in this country is concluded and the owners of the froth patent are now entitled to collect royalty from all those whom the law has defined as infringers, that is, anybody making a mineral-laden bubble for metallurgical purposes. What tax the Minerals Separation will, or can, impose we do not know. That will be disclosed in due course. Some facetious lawyers have suggested that the measure of benefit is the difference in the cost of the oil saved by the use of the M. S. patent as compared with the amounts used in the prior art. Ordinarily we would assume that the 'customary' royalty to be allowed by the Court would be that already specified in existing contracts, such as the one with the Anaconda and Inspiration companies, as published in our issue of September 16, but it is not improbable that Minerals Separation will endeavor to make the infringers pay more than its present licensees, who showed a willingness to recognize its patent rights before the Court compelled them to do so. In the Anaconda-Inspiration contract the royalty ranges from 12 cents per ton on a daily output of 4000 tons to 4 cents per ton on a daily tonnage of 30,000. On lead-zinc ores the royalty has varied with the richness of the ore, and has ranged between 15 and 20 cents per ton. On gold ores the usual royalty has been 25 cents per ounce of gold. These figures furnish a basis for guessing what may be demanded. We do not hesitate to say that the Minerals Separation people will make a serious blunder if they try to exact punitive royalties. The litigation is not necessarily at an end; the Elmore air patent has not been cited as yet against the froth patent and it offers scope for much more trouble, particularly as the American rights to this prior patent are now owned in the United States. Minerals Separation has a chance to avoid further bitterness of feeling by being reasonable—even generous. A royalty of 10 cents per ton on copper ores and of 25 cents per ounce on gold ores would do no great hurt to anybody and would give the patentee an income of at least \$3,000,000 now, with the prospect of a great deal more in the future. We note that the British company has transferred its American rights to a new corporation registered in Maryland and called the Minerals Separation North American Corporation. This is done, we presume, to remove the stigma of the foreigner; but we submit that prejudice against the company can be obviated much more effectively by a display of generosity toward users of the process instead of taking reprisals such as would invite litigation that might out-last the short life of the patent.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

A Matter of Principle

The Editor:

Sir—The 'reply' of the editor of the MINING AND SCIENTIFIC PRESS to the writer's communication of November 6 bears out the impression that some of its Eastern readers conceived in the first place, namely, that the securing of action by the San Francisco section of the American Institute of Mining Engineers on the so-called Shockley episode, and the publication of the objectionable matter in the MINING AND SCIENTIFIC PRESS, were more for the purpose of making copy for that journal, than to do justice in a controversy involving "a matter of principle," and in which the editor would make it appear "a wrong is done to a member of our profession."

The editor takes the opportunity in his 'reply' to impugn the writer's integrity and thereby offers a gratuitous insult. No notice would be taken of this, however, and, so far as the writer is concerned, the incident would be closed, if the editor had not followed it with a misleading statement in which he, with evident intent to deceive his readers, apparently quotes from the writer, but quotes wrongly, omits important portions of the statement, and thereby does the author of them gross injustice. Furthermore, in order to indulge his well-known propensity for making a quip, the editor "takes a fling" at the anthracite industry which lacks only one essential—the truth—to give it justification.

The misquoted statement which the editor attributes to the writer is made in the following tenor: "Mr. Parker's estimate of the earnings of the anthracite miner is \$628." Mr. Parker made no such statement. What he did say in a letter to the chairman of the Anthracite Section, and which was sent to Mr. Shockley was that in a report to the Anthracite Coal Strike Commission "a statement by the Lehigh Coal & Navigation Company showed that the *contract miners* in their employ in 1901 earned \$738.84, which, with the increases in 1902 and 1912 would make the wages of their contract miners at the present time for the same number of working days, \$894," and that on the same basis of deduction the average yearly earnings of *all underground employees of the same company* would be \$628. The latter figure included the wages of door-boys, drivers, and all other low-priced labor. The editor has compared the highest priced labor in the Colorado mines with the average of all underground labor in the employ of one anthracite company. It is to be noted that in the foregoing extract

from the letter to the chairman of the Anthracite Section the writer said "for the same number of working days" as in 1901 the earnings of the anthracite miners for this one company in 1915 would be \$894. The statistics for 1915 were naturally not available on October 13 of that year, however the editor of the PRESS may desire to distort the statement. They have since been published and show that the anthracite mines worked an average of 230 days. In 1901 they worked 196 days, the ability to earn in 1915 being, therefore, increased by 17% over the above estimate for that year. The editor may draw his own conclusions as to the correctness and fairness of the manner in which he has "quoted" the writer.

The writer's present position is one of confidence and trust; for twenty-five years he held a similar position with the United States government, and so far as he knows was never guilty of a breach of faith. It is a little late in life to break a habit. It is not the writer's desire nor his intention to continue this discussion, nor to bandy words or phrases with the editor, who will naturally take advantage of his position to have the last word and who is disposed to juggle with figures to meet his requirements. The writer has been accustomed to dealing with facts and of interpreting statistical data conscientiously; wherefore he does not feel qualified to cross swords (or pens) with the editor of the PRESS. Moreover, he has a very lively recollection of a charge once made against him by the present editor of the MINING AND SCIENTIFIC PRESS, who when shown the baselessness of the charge, apologized to the writer, it is true, but did not consider it necessary as "a matter of principle" to acknowledge his error to the superior officer with whom the complaint was lodged, and the *amende honorable* has, accordingly, never been made.

E. W. PARKER.

Wilkes-Barre, December 2.

[Mr. Parker is welcome to the "last word."—EDITOR.]

The Editor:

Sir—Mr. E. W. Parker, Director of the Anthracite Bureau of Information, in a letter dated November 6, published in your issue of November 25, criticizes the San Francisco Section of the Institute for the passing of a resolution based "entirely on *ex parte* evidence and on a matter with which it was not in any way familiar."

As Secretary of the San Francisco Section, I am somewhat familiar with the manner in which the Shockley matter was considered by the Special Committee and can

inform Mr. Parker that the Committee was familiar with the letters and telegrams of both sides of the controversy. These documents were sufficient to indicate the fact that the Board of Directors of the American Institute of Mining Engineers had ordered the management of the International Engineering Congress to delete from Mr. Shockley's paper certain statements based on published Government and State statistics.

Mr. Parker is evidently not familiar with the protest of the San Francisco Section, which has not attempted "to pass judgment upon a matter affecting a region and an industry with which it is not familiar," but has protested against the action of the Board of Directors in interfering with the professional right of one of the members of the Institute to express his opinion in the Transactions of the International Engineering Congress.

C. E. GRUNSKY, JR.

San Francisco, December 6.

Flotation at the Calaveras Copper Mine

The Editor:

Sir—In the article by Hallet R. Robbins appearing in your issue of November 25, I find the following:

"Without wishing to draw invidious comparisons, it is interesting to note that the National mill in the Coeur d'Alene, built to treat 500 tons per day of a simple chalcopyrite ore, cost \$153,000, and has never made so close a saving as the Calaveras plant, and cost about the same to operate as the latter with its present small capacity of less than 200 tons per day. Of course, much less was known about flotation when the National mill was built than today."

Certainly only to those who are not familiar with the different conditions surrounding the two mills that are compared could such comparison be considered "invidious." Mr. Robbins has started out to draw a comparison that does not compare, and leaves the impression that, in his opinion, what can be done in crushing and treating an ore under one set of conditions, and in one locality, should be duplicated under different conditions if the same talent is available.

The 'Mines Handbook' for 1916 describes the ore of the Calaveras Copper Co. as follows:

"Ore occurs in amphibolite schist underlying Mariposa slates, near intrusions of granodiorite, the *ore-bearing schists* ranging 100 to 200 ft. in width."

The same authority describes the ore of the National Copper Co. as follows:

"Ore occurs in a fault-vein in thickly bedded *white Revett quartzite*."

We hardly think that Mr. Robbins means us to assume that, in his opinion, white Revett quartzite can be reduced to the same mesh with as little expenditure of power, wear and tear, attention, etc., as would be required for schist. As a matter of fact, the white Revett quartzite at the National Copper mine was found to be of sufficient hardness to serve excellently for tube-mill

pebbles, and caused the most excessive wear on cheek-plates, liners, pebbles, and all wearing parts, that those connected with the construction and operation of the plant had ever experienced before, or since. Another point that should have been brought out, if a comparison were desired, is that the National Copper mill was built in 1913, before the development of the ball-mill to its present stage of usefulness. Had ball-mills been available at that time, they could have taken the place of the rolls and Symons screens in the dry-crushing plant, and the first series of Hardinge mills in the wet plant, materially reducing the cost of the mill, and the subsequent operating cost.

Mr. Robbins also states that the National Copper mill never made so close a saving as the Calaveras plant. In this he is in error. The National Copper mill-feed averaged 0.8% copper and often less. The tailing, during the later operations, averaged 0.02% copper. The saving, therefore, was closer, although, because of the extremely low heading, the percentage of copper per ton of ore was not so high.

As to the cost of the National Copper mill, this figures out at \$306 per ton of daily capacity, and includes excavations, concrete work, buildings, etc., as well as machinery and equipment. This price, considering the nature of the ore, the fineness to which it is necessary to crush, and the fact that the mill was built during a severe Coeur d'Alene winter, compares favorably with average costs under similar conditions. I cannot compare it with the cost of the Calaveras plant because I have not the necessary figures and facts to enable me to make such a comparison, and without these, I might reach erroneous conclusions and mislead your readers.

As to the pneumatic cells described and illustrated, these are, like several others, self-evidently an imitation of those used at the National plant, in which it is hard to see where the improvement comes in. One would have more respect for the cell illustrated if it had some points of originality.

Salt Lake City, December 2. ERNEST GAYFORD.

The Extra-Lateral Right

The Editor:

Sir—I have just read with interest Mr. Colby's article in your issue of November 11, and note a misconception in his allusion to the period during which extra-lateral pursuit of a lode was permitted in British Columbia.

I have not at hand all the old British Columbian statutes, and therefore cannot say just when extra-lateral right was first granted. The Mineral Act of 1884 certainly specifically afforded that right, and I myself am working claims possessing it, located in 1883, probably under the Act of 1882. To go back no further, it is plain that the right was permitted for at least ten years, and it required considerably more than the "brief period" mentioned by Mr. Colby (from the coming into force of the Act of 1891 to that of 1892) to establish the conviction in the minds of those concerned, that the evils

which have proved to be virtually inherent in the "old law" were greater than its supposed benefits.

Fortunately, I believe, the change of law was made before either British Columbia had become 'fashionable' with mining investors in London, Montreal, or New York, or any great number of claims had been staked. The Act of 1892, prescribing vertical limitation of mining rights was passed with but slight opposition, and the principle has become so thoroughly established, that we hardly realize that it has, without doubt, been accountable for the almost complete freedom from litigation concerned with underground trespass, enjoyed by claims located since the spring of 1892. It is an interesting and important matter of fact that the only two big lawsuits* arising from instances of underground trespass (whether alleged or actual matters not) which have been tried in British Columbia, concerned claims possessed of extra-lateral rights, and it is probably not far wide of the mark to assert that these two cases cost as much as all the other mining cases of the Province combined.

The increasing importance and present magnitude of the metal mining industry in B. C. are sufficient refutation of the dicta of those who, almost twenty-five years ago, had very clear visions of stagnation and decay, if not of disaster, following closely upon abolition of extra-lateral rights.

S. S. FOWLER.

Riondel, B. C., November 25.

Absorption of Gold by Plates

The Editor:

Sir—The absorption of gold by copper plates, mentioned in your editorial columns of November 18, is a matter of commercial as well as of technical interest, particularly to those who have to do with mills where plate-amalgamation is practised.

Figures are quoted giving the yield from the 'sweating' of old plates. The connection in which the term 'sweating' is here used is somewhat ambiguous. As "old plates" are mentioned, it is fair to assume that the plates were no longer in use and that it was intended to remove all the gold and amalgam from them that was possible. To do this, 'sealing' of the plates would have to be resorted-to, an altogether different process from sweating.

The actual procedure in the process of sealing varies in different regions. In some places in this country, plates are sealed by hammering and buckling the plate. In South Africa the plate is heated over a wood-fire to a temperature sufficient to volatilize the mercury. While still hot the surface is treated with strong hydrochloric acid and then with a saturated solution of ammonium chloride and saltpetre. After standing for several hours the plate is again heated to redness, whereupon the seal-rises and can be collected on cooling.

'Sweating,' as generally understood, consists in subjecting the plate in place to boiling water, or steam under

low pressure, and the removal of the softened amalgam by means of a wooden chisel or other hard scraper. In the treatment of plates to recover all the gold or amalgam, they are first sweated and afterward sealed.

At some mills the sweating is done at regular intervals, so that large accumulations of amalgam on the plates are obviated. In other places the opinion is held that plates which have been sweated do not recover their maximum efficiency for a while and that the loss occasioned in this way more than equals any gain derived from systematic sweating. There is something to be said in favor of this view, but the argument loses force as the accumulation of gold increases in value. Undoubtedly there are also cases where a considerable quantity of amalgam has been allowed to accumulate on plates, not as a result of the definite policy of the management, but simply because the extent of the accumulation was not known or suspected. In one instance within my knowledge a large amount of amalgam was recovered from plates after it had been decided to close-down the mill, and the large sum realized came as a pleasant surprise to both the management and the shareholders.

It will be gathered from the preceding remarks that the amount of amalgam which may accumulate on plates depends upon whether or not they are sweated periodically. The rate at which amalgam accumulates depends upon a number of factors, chief of which is the method of working the plates. This is seldom the same in different places. In South Africa and New Zealand it used to be common practice to keep the top half of the plates 'wet,' or soft, and the lower end 'dry,' or hard, these terms referring to the condition of the amalgam. The surface of the upper part of the plate was kept in a soft condition by the application of sufficient fresh mercury at each dressing. At the daily clean-up all the amalgam that could be scraped together with a light iron scraper from the soft portion of the plate was collected. A portion of this was cleaned on the plate by washing with water from a hose and mixed (to the proper consistence for rubbing on the plate) with fresh mercury. This was then rubbed into the plate with a blanket swab. The lower or 'dry' portion of the plate was dressed by rubbing heavily with a canvas pad. No amalgam was taken off this part of the plate and it was not usual to apply fresh mercury, the surface being kept in the right working condition by absorption of the mercury draining from the upper part of the plate during operation. At the larger of the mills of the Waihi company in New Zealand it used to be the custom (amalgamation has now been discontinued in favor of all-cyaniding) to steam the hard amalgam on the lower half of the plates at the rate of two plates per week, and as there were 15 plates, each plate was treated thus about once every seven weeks. The portion of the plate to be steamed was covered with canvas stretched on a light wooden frame leaving about three inches between the canvas and the surface of the plate. Steam from a hose connected with a boiler was forced, under this canvas frame for 30 to 60 minutes, according to the supposed extent of the accumulation.

*Center Star v. Iron Mask, and Star M. & M. Co. v. Byron N. White Company.

The plates were of Muntz metal and it was necessary to exercise some care in order to prevent buckling and cracking of the plate by keeping the steam-pressure low and not allowing the jet to impinge directly on the plate. The scraping operation took two men about 30 minutes per plate and was done with wooden chisels having a steep edge. The amount of steamed amalgam obtained in this way from two plates was approximately 1000 ounces. The total recovery of gold by amalgamation was approximately 23% of the total gold content. The gold was finely and evenly distributed through this ore and was never visible to the unaided eye.

This system of working the plates was particularly well suited to the ore at Waihi, where it was not sought to obtain the maximum recovery possible by plate amalgamation, but rather to recover the more easily amalgamable gold, leaving the finer gold to be recovered subsequently by cyanidation. In other places hard amalgam is not intentionally allowed to accumulate in the way described. Usually the entire surface is kept soft, and scraped as closely as possible at each clean-up. If an iron scraper is used for this purpose the accumulation of a large quantity of amalgam may be prevented, but if only india-rubber scrapers are used, a skin of hard amalgam will continue to form until removed by the sweating of the plate. This, in some instances, may not be done until the plate is no longer required for amalgamation.

It will be gathered from the foregoing that the amount of amalgam accumulated on plates, recoverable by sweating, cannot rightly be considered as a factor of the tonnage, nor yet of the time involved in its accumulation, but that it is altogether dependent upon local circumstances and expedience.

After plates have been in use for some time (unless special care has been taken to prevent it) a scale of hard amalgam forms on the surface of the copper. This is not easily removed by sweating, being difficult to soften on account of the small proportion of mercury in its composition. Such a superficial scale can be removed only (and not completely even then) by scaling. It is the gold in this scale that is generally said to have been 'absorbed,' but this is an instance of incorrect terminology, for it has been conclusively shown by investigators that neither mercury nor gold is absorbed by the copper in the sense that it soaks into the copper plate, but that it exists, as already stated, as a scale on the surface. Stanley's investigations in South Africa* have shown that 99% of the gold remaining after sweating is in the top or surface layer, 0.02 inch thick. He showed further, by microscopic examination of sections of a plate, that the little gold remaining existed as a filling in minute pores and blow holes in the copper into which mercury carrying gold in solution or suspension had percolated. Richards† also investigated this matter and showed that the amount of gold below 0.01 inch was negligible.

The amount of gold left on plates after careful sweating has been variously recorded as 8 up to 45 oz. per plate. This depends upon the thoroughness with which the sweating has been done and also on the condition of the surface of the copper of the plate. The surface of very old plates becomes covered with inequalities that make it difficult to remove the hard amalgam. If the operation of scaling is performed carefully, the value of gold left on the plate is negligible, and certainly would not pay for further treatment. Much less would it be worth while, as was the old custom, to send it to the smelter, save for its copper value.

WILLIAM MACDONALD.

Berkeley, November 22.

RUSSIAN PETROLEUM PRODUCTION, prices, and shipments from January to April inclusive, show points of special interest. The period covered by the statistics is unusually recent to appear in so careful a study; the detail in which the returns are given suggests an authentic source, possibly the official figures of the Petroleum Convention itself, and the picture of the whole industry which even the colorless figures of the review suggest, shows both depressing and stimulating effects which have resulted from war-time conditions. In spite of a greatly increased demand for oil-fuel, due to interference with the usual coal supplies, the total production of petroleum in the whole Empire for the first third of the year showed a decrease of three million poods (1 pood = 36 lb.) in comparison with the same period of 1915, thus continuing the decrease in output which has been marked for several years past. Apart from influences previously active, this decrease may be in some degree due to shortage of labor and materials, and difficulties with transportation such as would naturally arise from the War. Marked increase of production during April 1916, amounting to 2.1 million poods in comparison with April 1915 (most of the increase occurring in the Grózný and Surakhán fields) shows on the other hand that the stimulus of the War markets has taken effect. It seems reasonable to expect that for the whole year the total output of the Empire will be considerably larger than that for 1915. *Russia*, published by R. Martens & Co., Incorporated.

FIBROUS STRUCTURE in minerals is thus explained by Dana, in his 'Systematic Mineralogy': "When a solution is spread thinly over a large surface, minute crystalline points enurst the whole, and if the solution be gradually supplied, as crystallization goes on, it is obvious that the minute points may elongate into crowded prisms of fibres, producing a fibrous structure. Such a structure is common in narrow seams in rocks, and the fibres are usually elongated across the seam." Chrysotile is an excellent example of this type of structure.

*Trans. Chem. Met. & Min. Soc. of South Africa, Vol. 12, No. 6.

†Ore Dressing, by R. H. Richards, Vol. 2, page 76.

DIVIDENDS paid by the Broken Hill Proprietary, Australia, during its last half-year were \$580,000, making a total of \$61,135,000 since 1885.

The Prevention of Misfires

By E. F. Brooks

Blasting, or breaking of ore and rock, constitutes a large item of expense in mining, and any reduction of this expense is always welcomed. One way of reducing cost would be to lessen the number of 'misfires' or missed holes, as they are commonly called in the mine. Precautions may be taken to reduce them to a minimum. They are sometimes caused through poor judgment in placing the holes, the first hole to be fired breaking to a joint or cleavage-plane, tearing off the collar of some other hole, and with it the fuse, causing a 'miss.' No inflexible rule can be given for placing a round of holes, as this depends entirely on the character and hardness of the ground to be broken. The machine-man must use his judgment, which only becomes ripened through experience. The fuse should always be of the best quality, whether in wet or dry ground. A poor quality of fuse is dear at any price; the best fuse is always the cheapest, as one misfire, due to poor fuse, particularly in hard ground, may result in more damage than the cost of several cases of good fuse. The same applies to detonators, or caps. The best results are obtained by using high-power caps, 5X or 6X. In the case of gelatine powder, it frequently happens that a 3X or 4X cap may still fail to explode the charge, merely setting the dynamite on fire, causing a 'burnt hole,' which is worse than an ordinary 'miss,' owing to the resulting noxious fume, which is more poisonous to inhale than the fume from powder that has exploded properly. A 'burnt' hole, in the absence of good ventilation, usually means a headache for the next shift.

Nothing weaker than 5X or 6X caps should be used. Misfires may be caused by not using proper care in cutting or 'spitting' the fuse, so that the holes will go in proper succession, the hole that should be second or third sometimes being the first to explode, possibly tearing a portion off the collars of the holes that should have preceded it; pulling out or cutting off fuses and resulting in one or more 'missed holes.' If in hard ground, such a result is likely to spoil the whole round, leaving in the face holes of varying depth, called by miners 'old bottoms,' 'old guns,' 'boot-legs,' and so forth, each containing from one to four or more sticks of powder, and constituting a menace to those who have to work later, whether the men of the same shift or others.

Another occasional cause of missed-holes, and one I have never known miners to take into consideration, is tamping. Many years ago, when black powder was the explosive used, it was necessary to tamp holes, and tamp them firmly, using a wooden or copper rod, and a hammer for the purpose. This is unnecessary in the use of nitro-explosives, as even the air itself will offer sufficient resistance to exploding dynamite to constitute good tamping.

It is a common practice with most miners to use some kind of tamping. Sometimes fine rock, or dirt, is thrown

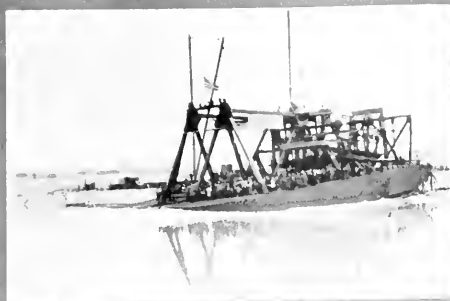
in the hole, and rammed with the loading stick; at other times balls are made of clay or gouge, and firmly rammed, which is even worse than using fine rock, for the reason that the side-spitting of the fire in the fuse will sometimes set fire to the powder, which, while it does not explode, will generate sufficient gas to force the tamping out of the hole, drawing the fuse with it and leaving another 'missed hole.' Had there been no tamping used, even if the powder took fire and burned faster than the train of powder in the fuse, it would explode the charge as soon as the fire reached the cap.

I would suggest that in holes pointed downward, a handful or two of fine dirt be thrown into the hole, but not firmly tamped, using this as a safeguard against accidents when firing or 'spitting' the holes, such as the accidental dropping of a lighted candle into the hole, or dropping the lighted end of a fuse into it.

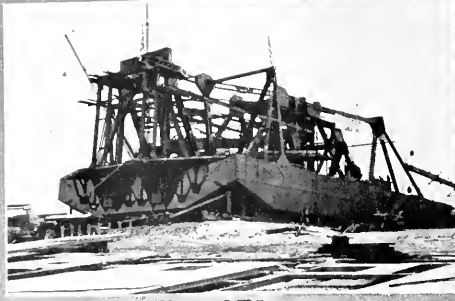
Many times 'reports short,' or 'misfires,' are traceable to carelessness, or to the nervousness, due to inexperience, of the man 'spitting' the round of holes. In his haste to leave, the miner overlooks some of the fuses, and so fails to spit them. Evidence of this is not infrequently found in the broken rock—a fuse with cap attached—which, upon examination, shows that it never had been lighted. A fuse cut to proper length will give the miner abundant time to reach a place of safety.

In blasting under water or in wet ground, it is absolutely necessary to see that the point of union between fuse and cap is waterproof. This may be accomplished with a good pair of crimpers, properly used, without the use of any waterproof substance, such as axle-grease, which is so commonly used for this purpose. However, it is generally safer to employ some kind of waterproof substance. But axle-grease, or anything containing coal-oil, is not recommended, for, if left too long, it will penetrate the fuse, and possibly cause a misfire. There is on the market, and handled by most dealers in powder, a preparation made for this purpose that is more reliable than most kinds of grease or wax.

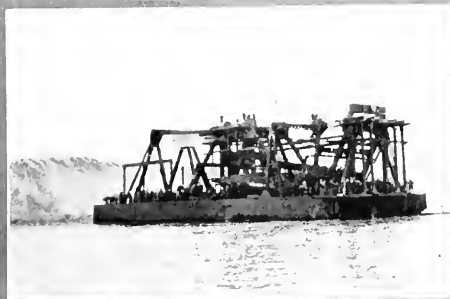
The kind of crimpers used is largely a matter of preference. I prefer those making a groove around the cap. Make a double-crimp, turning the fuse slightly after making the first crimp, and take care to crimp close to the joint between the fuse and cap, but never close to the fulminate in the cap, for if crimped too close to the fulminate the flash from the little powder remaining in the fuse between the crimp and fulminate may not be strong enough to explode it, while if $\frac{1}{2}$ in. or so of fuse is left below the crimp, the force will be sufficient even if tightly crimped. Care should be taken to see that the diameter of the fuse is just slightly smaller than the shell of the cap, for if too tight, the crimper will compress the fuse so tightly that the fire may fail to pass the point of compression, when there is created another cause for a misfire. By observing the foregoing suggestions, with ordinary care the miner will reduce to a minimum the chance of having 'missed holes,' and instead of being the rule, they will become the exception. Above all things do not use the teeth for a crimper.



LAUNCHED



ON THE WAYS



TO THE FAR SIDE OF THE POND



YUBA DREDGE, No 15



LOOKING EAST No 15 DREDGE

The Launching of the Yuba No. 16

By Walter E. Weeks

The reasons why the PRESS selected me to 'cover' the launching of the 'Sweet Sixteen' of the Yuba Construction Co., built for the Yuba Consolidated Goldfields Co., may be enumerated as follows:

A new Graflex camera.

An amphibious Ford.

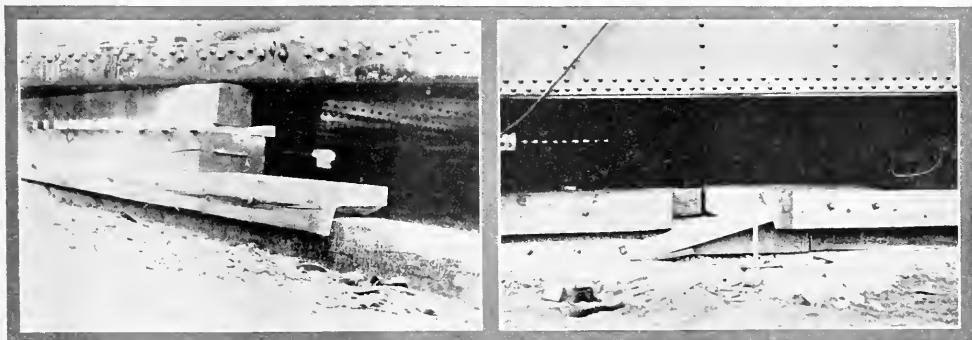
An invitation to a turkey dinner at the construction camp at Marysville.

The band played, the whistles blew, the flags waved, and everybody cheered as the great black hull slipped smoothly into the muddy pond, driving a curling wave before it which rocked shoreward until it broke against the hills of tailing.

I stood on a bit of an island in the pond, and it was hard to realize that I was not in Kennebunkport, Maine, watching the good ship *Mary Jane* take her maiden dip.

The new dredge seemed anxious to be about her stupendous task, for she could not wait to have all of her triggers sprung, but started down the ways crushing the two inside 4 by 4 timbers that tied her to the land. Down she went with a dignity comparable only to the precession of the equinoxes and glided majestically to the farther side of the pond. Then a rope was rove about her taff-rail and a tiny Yuba tractor like Ulysses was called from the plow to pull her back to shore. But the good ship, as if resentful, snapped the line. She was finally subdued and now floats meekly at her berth while the various appliances that are considered good form in gold-dredge construction are heaped upon her. When finished she will weigh 2700 tons, will have buckets holding 18 cu. ft., able to dig to a depth of 84 ft., and with a monthly capacity of 350,000 cu. yd.—all at a cost of half a million dollars.

But why, you may ask, do I not give the size of her waist (nautical term) and other useful and entertain-

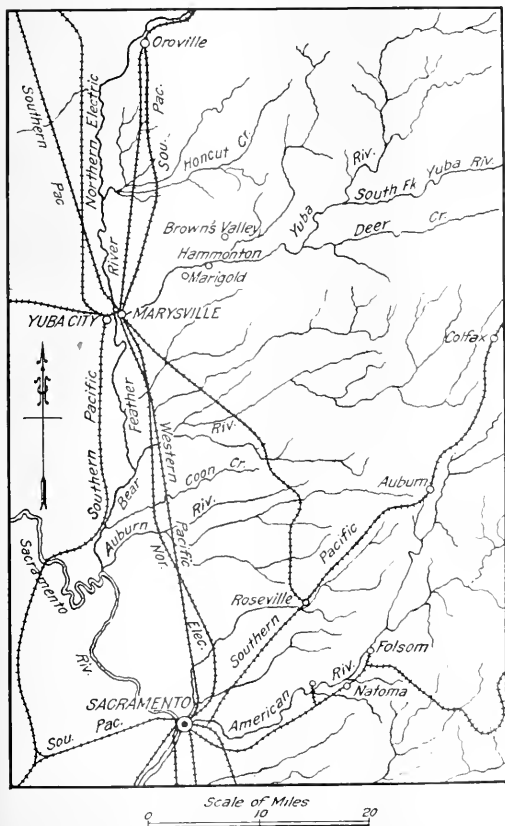


SECTION OF DREDGE HULL AND WAYS BEFORE LAUNCHING.

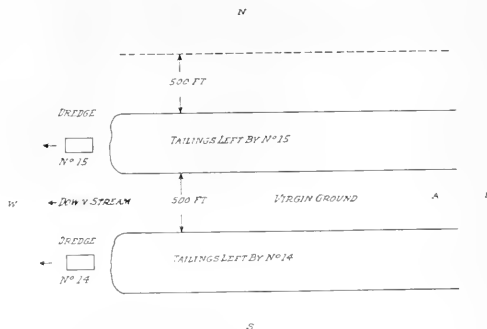
ing dimensions. It is because with the exception of the tailing-stacker she will be almost a duplicate of her sister boat No. 15, which has been thoroughly described. The picture shows No. 15 in her present position. No. 16 will have two tailing-stackers each 220 ft. long, placed at the stern, but stacking one to each side. This construction has been adopted to comply with the mandate of the

Débris Commission that a 1000-ft. channel shall be left through the dredging field. No. 16 will dig one-half of this channel and a later boat will dig the other half.

The accompanying sketch shows where dredges No. 14 and 15 are working. No. 16 will enter the field at A and, working down-stream, will remove the virgin ground between the two piles of tailing left by No. 14



MAP SHOWING PRINCIPAL DREDGING DISTRICTS OF CALIFORNIA.



THE NEW BOAT WILL START DIGGING AT A.

and 15. The ground will be excavated in two cuts, each about 250 ft. at the surface. When No. 16 is taking the right-hand cut the starboard staker will pile the tailing on those already left by No. 15, and when she is taking the left-hand cut the port staker will pile the tailing on that left by No. 14. In this way an open channel 500 ft. wide will be left through the dredging ground. Another 500-ft. channel will be dug by a later dredge to the north of the tailing-pile left by No. 15, giving a total width of 1000 feet.

The bottom photo of the group shows the virgin ground between the two tailing-piles. The picture is taken looking east. No 15 dredge is on the left.

In 1915 Yuba county held third place in rank of gold producers, being exceeded only by Amador and Nevada. It holds the leading position in production of placer gold, by reason of its gold-dredging activities. The output of the county in 1915 was 130,792 fine ounces of gold, valued at \$2,703,710, and 10,363 fine ounces of silver. There were 12 dredges in operation in the county in 1915.

Conditions in Mexico

By Our Mexican Correspondent

It is curious that Carranza's banking decree of September has not caused more comment in the United States. Aside from a protest made by the diplomats representing European powers before the United States-Mexican Commission, nothing seems to have been done to enlighten the American public as to this bold pronouncement, which may prove later to contain more international political dynamite than all the other Carranza decrees put together. A condensed translation is as follows:

"V. Carranza in use of the faculties of the Executive Power of the Nation, and considering:

(1) That the Executive Power is under obligation to fulfill the Constitution and is competent to abrogate unconstitutional laws and concessions.

(2) That the laws which establish banks of emission, allow them the privilege of emitting notes in excess of their metallic reserves without paying any compensation to the Nation, and permit them to cash in their mortgage credits without a judgment, and exempt them from taxation, are unconstitutional. Because Article 28 of the Constitution declares that there shall be no monopolies under the guise of protecting industry; and diverse rules of the Constitution prescribe that laws must be applied equally to all litigants, and that none may enjoy advantages except in return for public service. Also it is forbidden to restrict the States by exempting banks from local taxation.

(3) That the application of ordinary law to banks might bankrupt them and bring back the financial crisis, besides giving rise to many legal questions to the injury of bank investments that should be protected by the State, even though the banks were created under illegal franchises and laws.

(4) That the bankruptcy of enterprises entrusted with public services requires the naming of Boards of Receivers (*Consejos de Liquidacion*) who may take charge of the disputed interests. In the present case, it is convenient that, for the management and liquidation of the banks, legal representatives of all interests should take part.

Thus I have decided to decree:

Art. I. There are abolished all laws giving franchises to banks of emission; and the corresponding part of the general banking laws of 1897 and 1908, by which these banks have the monopoly of note issues, and are allowed to follow unusual procedures in judicial actions, and are exempt from taxation.

Art. II. There are allowed to banks of emission a period of 60 days from date in which to increase their metallic reserves enough to pay all their notes in circulation.

Art. III. After today, the said banks can only do business when authorized by the resident inspector (*interventor*) of the Treasury (*Hacienda*), and of a sort to protect the bank's interests.

Art. IV. The Secretary of Hacienda will at once proceed to name for each bank of emission a Board of Receivers, which will consist of a member of the Commission of Bank Inspection, a bank inspector, the bank manager, and a representative of the creditors. The latter's place will at first be filled by the National Procurator, or a specially designated agent of the Federal public ministry; but when the bank's creditors have met and selected, under material seal, a representative of the majority of its creditors, and so notified the Secretary of

Hacienda, the place of the temporary incumbent will be filled by the latter. The member of the Commission of Bank Inspection will be president of the Board of Receivers and have the decisive vote.

Art. V. The Board of Receivers will have the following powers: (1) Watch over the conservation of the specie. (2) Perform all kinds of operations whose object is to preserve the bank's interests. (3) Liquidate the bank, after getting permission of the Secretary of Hacienda, or in obedience to orders from him in case the bank does not increase its metallic reserve according to Art. II of this decree.

Art. VI. The Secretary of Hacienda, ex-officio or on request of an interested party, will decree all those measures that may appertain to the protection of the bank and to the action of the Board of Receivers.

Art. VII. The banks cannot be declared judicially bankrupt without permission of the Secretary of Hacienda.

Art. VIII. The distribution of the specie reserve of a bank can only be effected according to the orders of the Secretary of Hacienda.

Art. IX. In case of non-judicial liquidation, there must be observed, except for a law to the contrary, the graduations established by the common law for credits.

Art. X. The banks that comply with Art. II of this decree will be free from receivers, but will be subject to existing legislation in everything not contrary to this decree. Constitution and Reforms. Given by V. Carranza in Mexico City, September 15, 1916, to R. Nieto, sub-Secretary of Hacienda.

To get the proper perspective of this decree, I shall review recent events in Mexican finance. The wholesale repudiations, in June, of the old Carranza notes (published in the PRESS of July 15) failed in their object of validating the new 'infalsifiable' notes. The mere decree of the obligations of a debtor, if accomplished by dishonorable and violent means, will not increase the market-value of his remaining obligations. This statement applies to either public or private debtors, and its truth was never better demonstrated than by the fate of the infalsifiable notes after the 'massacre' of their predecessors last June. By August 1, three months after their debut, the new peso notes had dropped from their nominal value of 10 cents (U. S.) to 43c.; by September 1 they were down to 33c.; by October 1, 3c.; and by October 28 to 1.8 cents. Their present official quotation is 1.4c., and as the old notes are still receivable for a few public dues such as railroad fares at one-tenth their nominal value, this makes the value of the latter a tenth of 1.1 cents, or 0.14c. Thus the old notes are now officially declared by Carranza to have a value of only 1/360 of their nominal value of 50 cents, a record in depreciation that beats the famous example of the French Revolutionary *assignats*. Yet it was only last March that Carranza decreed the old notes to be "sacred obligations of the Nation," which could never, in honor, be redeemed at less than par.

The collapse of the new paper money during the sum-

mer aroused discontent in the army. Though the common soldiers were advanced from ₧2.50 to ₧3 per day, this had little effect, as all prices had long been approaching a gold basis. On the northern frontier and in the capital, the troops were kept quiet by giving them rations in addition to their wages, but elsewhere, where this was not done, various things happened. In the country, the soldiers took to foraging for a living more actively than before, and few were the Zapatistas of the animal kingdom, such as poultry, pigs, or lambs, that escaped their hungry maws. In the cities, a troop could often better its condition by deserting bodily from one barrack to another; and, as the Carranza military organization is not centralized, but Federal, there was nothing to prevent an ambitious general from thus increasing his forces at the expense of his rivals.

The peninsula of Yucatan has been protected by its isolated position from the ravages of revolution, and has been fortunate in its Governor, the energetic and progressive General Alvarado. This State enjoys a big income from the *henequén* (hemp) industry, and its soldiers are paid so well in coin that were it not for the expense of the long journey, it is likely that not another Carranza general in southern Mexico could hold his troops against the superior attractions of the Yucatan service.

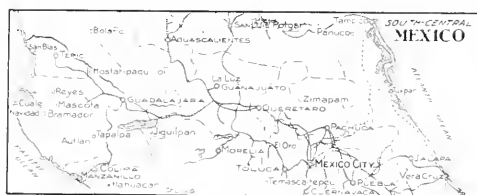
Early in September Cabrera decreed a *ley de pagos* (law of payments) that attempts to adjust debts unpaid or not yet due, in terms of the infalsifiable notes. It divides financial time into four periods, namely: (1) Normal, or when money was at par, before April 15, 1913; (2) from April 15, 1913, to September 30, 1914; (3) from September 30, 1914, to April 30, 1916; and (4) from April 30, 1916, to date.

During the first period, debts will be based on silver and may be settled in infalsifiable notes at a ratio of 5:1. During the second period debts will be based on bank-notes and may be settled in infalsifiable notes at ratio of 4:1. During periods No. 3 and 4, all debts will be based on Government notes and may be settled in infalsifiable notes at par. To this practically the only exceptions are debts payable in foreign money, which must be settled only in such money or its equivalent in Mexican gold. A curious feature is the regulation that allows certain favored classes of creditors to postpone for a year the agony of a payment in infalsifiable notes. Among these are charities and city councils, also the legally incompetent, the aged and invalids, provided only their capital is under ₧20,000 gold. Evidently any creditor, however crippled or ancient, who is enough of a plutocrat to own ₧20,000 gold has put himself beyond the pale of this precious *ley de pagos*.

As debtors had cheerfully been robbing their creditors with legal sanction ever since 1913, the new Cabrera decree did not cause much havoc; for creditors had already either lost their money or ceased to make loans. As it assumed a value of 10 cents (U. S.) for the infalsifiable peso, when its market-value was only 3 cents, the absurdity of the regulation was almost visible to the aver-

age Mexican—who is quite devoid of any mathematical sense. Soon, perceiving its practical uselessness, Cabrera decided to ignore it, as he has already ignored so many other of his progeny of still-born flats, and to proceed on a new tack, leading to speedy specie payments. In October it was decreed that all labor should be paid in coin at the rates of 1912, beginning on November 1; but later the Department of Fomento modified this decree by allowing 40% of wages, for rates under ₧1.50 daily, and 50% of wages, for higher rates, to be paid in infalsifiable notes until January 1, 1917. As there is scarcely any coin in circulation, the coin portion of wages can be paid in paper at the official rate, which is changed every 10 days, and was 25:1 on November 1, and 35:1 on November 10. All railroad charges, as well as national and local taxes, began to be collected on a gold basis on November 1, and mail-rates, payable in paper, were quadrupled on that date.

On the first decennial pay-day of the new system, on



November 10, the common soldiers were paid-off at a rate of 50 centavos in silver plus ₧1.50 paper per day, and officers proportionally higher. Few in the Civil Service fared as well, as most of them only got the usual Government notes as pay. Similarly, many factories were unable to meet the new exactions as to payment, and their men therefore went on strike. It took the United States from 1865 to 1878 to effect a resumption of specie payments, and it seems to be beyond the power of even Luis Cabrera to effect this change in three months. Of course, import duties could at once be collected in coin, but the collection from real-estate owners and merchants in November of just 25 times the direct taxes they had to pay in October is entirely another matter. Therefore most of the local taxes remain unpaid, and along with them the increase in the salaries of Civil officials. However, many of the latter are not suffering on this account, for, as the history of Turkey and China proves, an official may often wax rich on pauper's pay. It is a peculiarity of what little morality there is among Mexicans that it is a strictly private affair; thus an official who personally might be stainless, would work cheerfully and without a word of criticism beside the most flagrant of rogues. This national trait makes it improbable that Mexico can ever attain a civilized government from within, for few are the decent Liberals in Mexico who are not now working, without a word of protest, as aid to one of the most heartless rings of spoilers who ever had control of any modern country.

In 1912 there were 20 odd banks of emission in Mexico, mostly chartered by Limantour in 1897 and named from

the State where the main office was situated. These banks were authorized to issue notes and loan them on commercial paper up to double the quantity of their metallic reserves. Two banks only, the Nacional and the Nuevo Leon, were allowed to issue notes to thrice their reserves. Huerta was the first ruler to tamper with the banks; in 1913 he allowed them to suspend specie payment, and in 1914 he permitted them to expand their issues beyond the legal limit in order to grant him a forced loan of P50,000,000 in bank-notes. These measures began the decline in the value of Mexican pesos, which were quoted below 30 cents in July 1914. As explained in my letter published in the *PRESS* of January 29, the banks have long abandoned their usual functions and have only been kept open to handle a fraction of their former discounting operations. Though it has been their policy since 1914 to retain all bank-notes taken in, and to pay out only Government notes, there is still outstanding a great quantity of bank-notes, most of which are probably hoarded by the native middle-class, who were unable to get enough coin to embody their savings when the deluge of Government paper drove them to burying their fortunes.

Cabrera first tackled the banks a year ago, just after Carranza's recognition by the A. B. C. and B. U. G. conference, but as the attack depressed the value of Government notes, and seemed to be of no public advantage, he abandoned it after merely revoking the charters of a few of the minor banks. But this year, Cabrera has been compelled by his dire need to resume the bank-baiting game. His issue of infalsifiable notes is a complete failure, and the Mexican masses are now too well enlightened as to the paper-money fraud to permit the success of any more fiat currency. The only exit to this blind alley is the path of specie payment, and the banks have the specie.

In September, the acting-Secretary of Hacienda, R. Nieto, decided to intervene only the two largest banks of emission, the Nacional and the Londres of Mexico City. Nieto promised the other banks that he would not disturb them under the September decree until after October 31. But the managers of the two intervened banks proved lawless and stubborn, they refused to open their vaults, and were accordingly sent to jail; so Nieto determined to temporize no longer with anyone, and, withdrawing his promise, he intervened all the doomed banks early in October. The custom of Mexican banks is to divide the secret of the vault's lock among several persons, whose united efforts are therefore essential to open the combination. Faced by this obstacle, Nieto is making slow progress, though he has finally managed to open the Nacional and the Londres banks. A mere jailing of the recalcitrant bank-officials seems a feeble measure in view of the public need, and either a torture of the officials or a dynamiting of the vaults seems the only alternatives to quick fulfilment of the decree. It is planned to get from the loot of all the banks some 80 million pesos, and before this is spent Cabrera hopes that fortune will again direct him to some fresh store-houses of

coin. Should Wall Street still remain deaf to his appeals for a loan, there are still untapped reserves among American pacifists; thousands of these worthy people will undoubtedly only be too glad to invest the bulk of their fortunes in Mexican bonds, if only given the chance, in order to assist such a pacifist hero as Carranza.

The wholesale spoliation of Mexican banks may alarm some American statesmen, for fear that later, under the Monroe doctrine, the United States may have to reimburse the stockholders and depositors, mostly Europeans. That this fear is baseless has been shown by Ing. Rolland, editor for the Latin-American News Association of New York, which is busily circulating booklets in English to explain the Carranza government's doings to Americans. In an essay entitled 'Intrigues of Clergy against Monroe Doctrine,' Rolland says: "The capital placed at interest in Mexico is, by more than 80%, the property of one creditor only, the clergy. And the clergy within Mexico has Europeanized its interests. How? By making laws in the name of European bankers and pretending that the capital which supports and gives life to business here is capital belonging to the clients of said bankers, the savings of Frenchmen, Englishmen, Belgians, etc."

The agitation of the Mexican question in the recent presidential campaign in the United States seems to have done little beyond confusing the voters' minds. To be a good Republican, one had to approve of Henry Lane Wilson and of the recognition of Huerta; to be a sound Democrat, one had to defend with unctious all the countless blunders of President Wilson in Mexico since 1913. The prevailing ignorance of facts is shown by no one nailing the error of Senator La Follette, when he affirmed that Americans own in Mexico a third more property than the natives, 1057 millions against 793 millions, while all other foreigners only own 582 millions. La Follette took his figures, heedlessly, from Letcher's U. S. Consular Report of 1912, without stopping to consider how all the property of an industrial nation of 15,000,000 could only be worth 1932 millions of dollars or \$129 per capita, as compared with about \$1500 per capita in the United States. Figures don't lie, but surely liars do figure! It is probably little known in the United States what an influence the help of Carranza exerted for the re-election of Wilson.

The many Mexicans who were boldly "interfering in the internal affairs of the United States," by preaching for Wilson, met with little or no opposition, for the few former residents of Mexico, who alone had the knowledge to expose their yarns, did not care to lose their holdings in Mexico by attracting Carranza's adverse attention. The one-sided nature of the friendship for Woodrow Wilson was never better exhibited than in what happened in September to Burton Wilson, a lawyer of Mexico City and president of the American Club. The latter had directed to the United States-Mexican Commission a short history of Carranzaism in Mexico. On being confronted with this history by the American members of the Commission, Cabrera refused to con-

sider it until he was told the name of its author, whom he guaranteed immunity from any harm. Within a week this American viper was arrested and ejected by Carranza from the bosom of his outraged Mexico. On being blamed for this breach of faith, Cabrera merely shrugged and deplored the fact that his superior powers had not allowed him to extend the promised protection. A side-light on this incident is the recovery, by Burton Wilson's expulsion, of a palace long coveted by Carranza's 'Commission of Intervened Property.' The palace in the Colonia Roma of Mexico City belonged to Huerta's ex-minister Lic. Vera Estañol, who had rented it in 1913 at a low figure to his friend Burton Wilson, and the latter had for over two years succeeded in holding it against the attempts of the Commission to eject him. This Commission has had as many as 1000 houses and estates intervened at one time in the Federal district; but as it operates in secret and gives no public accounting of the 'reactionary' property in its charge, and the original owners are mostly in exile or in jail, it attracts little public comment.

Some events in August have strained to the breaking-point what once gave promise of becoming a touching international labor friendship. I refer to that between Gompers, president of the American Federation, and Carranza, erstwhile patron of the Mexican I. W. W. Last June it was perhaps more due to the pleading telegram from friend Gompers than to anything else that Carranza held his hand from exacting stern retribution on the U. S. Army for the Carrizal massacre. But in August, the labor-unions comprising the men working on the electric trains and power-supply of Mexico City—operated by Carranza—struck for the payment of wages in coin and announced the event by shutting-off all the current in town. Reversing the procedure of Wilson in the Adamson episode, Carranza, instead of being held-up by the labor leaders, clapped them in jail and gave them 48 hours to die or else stop the strike. It stopped, but so apparently has the international friendship.

As the leader of this strike, the anarchist genius, Dr. Atl, was arrested and condemned to be shot; but he appealed to his original Carranzista patron, General Obregon, and through his protection was enabled to escape to the United States, after a very close call. The fact is that Dr. Atl has been an eyesore to Carranza for some time, his labor doctrines had become as out-of-date as a last year's bird-nest, and in his editorship of the important Government daily, the *Acción Mundial*, he had allowed a passion for literary sensations to lead him often to the brink of the precipice of *lèse majesté*. What a mine for the inner history of the Carranza ring Dr. Atl might prove if he would open his heart to some enterprising American journalist! Carranza may yet regret his action; tyrants have been ruined ere this by cast-off servants of far less ability and audacity than Atl.

The famine predicted in my July letter probably caused less mortality than then seemed likely. But this outcome was due chiefly to having this year more favorable rain than in 1915, enabling the harvesting of 60%

of the normal crop. In June many places were without food, and in San Luis Potosi it was only the prompt action of the Governor in importing a train-load of grain from Michoacan that saved the city from decimation. However, the governors along the west side, from Leon to Zacatecas, were less energetic and lost thousands of their subjects from famine and its resultant typhus. The famine was aggravated between Guanajuato and Queretaro by some July cloud-bursts, to which was ascribed its entire origin by the official press-notices, but its real cause everywhere was not water, but two years of dosing by old Dr. Carranza.

There seem to be just as many Zapatistas as ever in southern Mexico, where Carranza has never held more than the cities and the railroads. When Pablo Gonzalez captured his capital, Cuernavaca, last May, Zapata merely shifted his headquarters to a valley farther east. During the summer, there was a lull in the combats between 'liberators,' but not because of any culpable decrease of zeal. The obstacle was the scarcity of cartridges due to the United States embargo, in force since April. What Carranza now wants most of all is his new cartridge factory, detained by the embargo; for with this factory he can provide cartridges by merely filling old shells with fresh powder, and can then feel independent of expensive new American cartridges. One would fancy that Zapata might have cartridges even if Carranza hadn't, but he would be wrong, for Zapata relies mainly for new cartridges upon their capture or purchase from Carranza officers. However, evidently tired of inaction, Zapata, a fortnight ago, posted notices all over his territory, warning travelers to beware of Carranza trains, as he expected to begin blowing them up. That this was no idle threat was soon demonstrated by the wrecking of the Mexicana railroad tunnel at Maltrata by the artificial collision of two trains, while on November 10 the Interoceanic train was derailed at Banderilla near Jalapa, and many passengers were killed.

As yet Carranza has shown no signs of abrogating his decree of last year, which forbids the sale of Mexican real estate to foreigners, though this decree was promulgated ostensibly as a temporary measure to protect simple native land-owners from the decoy of a depreciated fiat currency. Many of these simpletons are being made to pay dearly this year for protection, for they can only safely harvest their crops by agreeing to give 50% of them to the local general. Just before harvest, one 'honest' Carranza general bought a big ranch, whose crops had been cultivated by villagers on shares. But the new owner harvested all the crops for himself and the villagers found themselves with nothing for their pains.

GOLD received at the San Francisco Mint during November totaled 667,239.777 fine oz., and 1,115,453.45 oz. of silver. Coinage consisted of 5,400,000 dimes, 3,600,000 nickels, and 4,920,000 cents. The vaults contain \$426,173,268.95.

Gold in Silver Concentrate

By A. J. Sale

When concentrate carries three or four hundred ounces of silver and but one or two-tenths of gold, the assayer may have some difficulty in making an accurate gold determination. When a silver button contains less than 0.05% gold, the parting leaves the gold in such a state of division that, even if it does not 'break,' it has a tendency to adhere to the annealing cup. I have worked out the following method, which gives an accurate gold determination, even with the highest grade of silver concentrate that has ever come within the range of my personal experience:

Weigh an assay-ton of the pulp and place it in a clean clay crucible. Have the muffle at not quite red heat. Hold the crucible on its side and with a few light taps cause the pulp to distribute itself uniformly in the crucible. Carefully place the crucible near the mouth of the muffle and allow a full draught of air to pass through. After about 20 minutes' roasting, remove the crucible from the muffle and tip it the other way, so that the bottom layer of the pulp becomes the top. Roast 10 minutes longer, then take out and allow to cool. If the roasting is performed with care, the pulp will not matte or cake, and will not need re-grinding.

On top of the roasted pulp put a charge consisting of 25 grams bicarbonate of soda, 30 gm. litharge, and 12 gm. borax-glass. Mix, with a spatula, as much as possible in the crucible; then dump into a cloth and roll until thoroughly mixed, being sure to pulverize any lumps that may be present.

After mixing, the assay is given a cover of borax-glass and fused in the usual way, using a low heat at the start. A few trials will be sufficient to determine the exact time of roasting necessary to give the proper-sized lead button. Cupel as usual.

After cupelling, the silver button should be hammered flat and placed in a small porcelain crucible half-filled with 1:10 nitric acid. The acid is heated, but not allowed to boil.

When the action has proceeded so far that but few bubbles are being liberated, the gold button should remain intact, but will probably be swimming around on account of its spongy condition. When this stage has been reached, most of the acid may be drained off by holding against a stirring rod.

Cut a disc of lead-foil about an inch in diameter, and shape it into a small dish by pressing against the thumb. Into this dish carefully wash the almost parted gold button. Allow to settle, and drain off as much of the water as possible. Dry at a low heat, being careful that it does not 'spit.' When thoroughly dry, wrap the button in another piece of lead-foil; cupel; flatten the small silver button; part; anneal, and weigh in the usual manner. The lead precipitates the proper amount of silver from the nitrate solution to make a good separation of the gold, and the final button, while small, will be in compact form.

Recovering Gold From Saprolite

The saprolite of the southern Appalachian mountains is merely the much decomposed country-rock, principally schist and slate of various kinds. It is a name applied to thoroughly decomposed 'rotten' rock that is still in place. The composition is variable. In some districts the saprolite is gold-bearing. Rock of this description, particularly the red kind, was formerly called 'laterite.' In such rocks the gold occurs in the schist and in veinlets of quartz traversing it in every direction. Pyrite usually is found in the schist, particularly in close proximity to the quartz veinlets. It has been found desirable, if not actually necessary, to remove the hard lumps of mineral from the soft decomposed rock when attempting to recover the gold. These lumps consist of quartz and other hard rocks, in pieces ranging in size from an inch to a foot in diameter. Garnet also is plentiful in some localities. These hard lumps are removed by running the material, mixed with about an equal weight of water, through trommels having holes from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. diameter. The soft portion passing through the trommels goes to a 'washer' where the clayey earth is dissolved and the gold brightened, so that it will amalgamate readily. It is the practice to disintegrate the gold-bearing material before it reaches the trommel, and to accomplish this it is run through an iron-lined sluice, 50 ft. or more in length, set on a grade of 3 in. to the foot.

There are two types of washer used—high-speed and slow. The high-speed washer disintegrates the pulp by the beating of propeller-like blades on a revolving-shaft, which push the pulp forward up-grade to the discharge. Two of these machines comprise a set, and are arranged tandem. The first one, 18 ft. long, has a grade of 3 in. in its length, the shaft revolving 200 r.p.m. The second washer is 12 ft. long with a grade of 2 in., the shaft revolving 260 r.p.m. A screen follows each washer, the first of which removes oversize rocks, roots, and any other foreign substances that may be present. This screen is of woven wire with 3 or 4 holes per linear inch. The screen following the second washer is similar, but may be 6 or 8-mesh. Too much water must not be used, or satisfactory work is impossible.

The slow-speed 'log-washer' is similar to those used in iron-mining districts, and is adapted for heavier work. One of these machines will handle 1500 cubic yards of material in 10 hours. It is set at a grade of two inches to the foot. The slime flows out at the lower end, where the quantity of fine sand escaping can be regulated by means of the height of discharge and the amount of water used. The coarse sand and gravel are forced up-grade by the revolving paddles to the discharge-end, from which it goes through a double trommel, the inner one having 3-in. holes and the outer one 16 to 20-mesh. Slotted screens are used in these machines, as the material is all granular.

The operation of the log-washer was fully described by W. R. Dodge in the M. & S. P. of March 14, 1914.

The Hydraulic Air-Compressor

By A. E. Chodsko

It is a noteworthy fact that the Pacific coast of the United States, so liberally supplied with natural sources of water-power, already utilized in a number of important hydro-electric installations, should not present a single case of application of a process that has been turned to good advantage by our Canadian neighbors, as also in a few localities in this country and in Europe, namely, the hydraulic compression of air.

The increase of activity in the mining industry, caused by the present upheaval and by the fact that new metallic substances have recently been enhancing the general demand for further development in the opening of mineral deposits, may lend interest to a brief description of a device that some eminent technical writers have been satisfied to pass with the cursory remark that it is "the reverse of the air-lift." Here not improbably lies one reason for the indifference manifested toward hydraulic compression: a common notion exists that the air-lift, while a convenient and widely used contrivance for well-pumping, is unfit for mining practice, and the above opinion, expressed by accepted professional authorities, contributes to relegate in the make-shift class a system that, when rationally used, surpasses in efficiency the most advanced types of mechanical pumping-plants.

Another cause of reticence on the subject may be found in the fact that so far, its successful applications have been made on a large scale, so that the superintendent of a mine of moderate size, and disposing of a limited amount of water, naturally enough deems it useless to look into its possible use for his own requirements. Finally, it is safe to say that while the process itself is by no means novel, little is generally known about its practical use; as in other questions of commercial popularity, both truth and error can be found in these arguments. They are well worth a few moments of attention because not uncommonly have valuable processes or articles been condemned simply because they were applied out of season and under faulty conditions.

In the first place, and without dealing with the air-lift beyond the statement that under ordinary and practicable circumstances it is eminently adapted to mining work, nor is it true that the principle of operation is reversed in hydraulic compression.

True it is that they present some traits of similarity; in both of them, air and water are circulated side by side in immediate contact, and a satisfactory degree of efficiency requires a proper volumetric proportion between the two fluids; in both, also, the principle of operation lies in the difference of weights between two liquid columns in communication. The modes of action of the two machines are, nevertheless, widely different, as also are the determinations of their elements.

J. P. Frizell, who originated that system in 1878, contends that the volume of air drawn by the water into the induction-pipe (Fig. 1) automatically adjusts itself to balancing its contents and those of the return-column. That statement is too vague to satisfy a man who, having at his disposal a given amount of water, wants to know how much air he can raise with it to a given pressure. C. H. Taylor, of Montreal, attempted to answer that question by constructing in 1896 at the Magog mills, Quebec, a hydraulic plant that successfully supplied power to a number of compressed-air motors. In that installation, a volume of free air from 1377 to 1616 cu. ft. per minute was compressed to 52 lb. effective per square inch by a volume of water from 6122 to 7162 cu. ft. per minute respectively, with a fall of from 21.2 to 22.3 feet.

Prof. C. H. McLeod, of McGill University, performed in August 1896 on the Magog plant some tests that showed an efficiency ranging from 53.5 to 62.4%. Encouraging as were these results, they could not outshine customary makes of air-compressors in the competitive field; the tests suggested a better proportion between the main parts of the machine, and further attempts justified that provision.

The efforts of the promoters of the system were rewarded by such marked progress that a hydraulic compressor nowadays can be established under guarantee of showing a higher total efficiency than a reciprocating or centrifugal machine for the same capacity and air-pressure. That efficiency is permanent, because deterioration is practically absent, and no apparent reason exists, barring accident, why a well constructed hydraulic compressor should not be in as good condition after years of continuous use as on the day when water was first turned on. Nor does its relative superiority stop here; while, like any power-plant whatever, the hydraulic compressor demands some attendance, this does not compare with that required by a mechanical plant of like capacity.

This, indeed, does not imply an unrestricted commendation of that type of compressor; its success is primarily subservient to natural conditions that do not exist everywhere, even in regions where it would seem to warrant consideration. But when these requisites are fulfilled, the manager in need of compressed air should be enabled to figure out, at least approximately, as he would for steam, electric, or water power, the nature and the cost of the work involved in the prospective equipment.

Many will hesitate to apply for advice to exclusive firms, who not uncommonly seem to treat a mere request for information as the forerunner of an immediate order,

and they naturally prefer to work the matter out by themselves. Professional inquiries received from mining men satisfied me that the elements of such estimates are lacking, and they have prompted me to present a few pointers that may prove useful. Such suggestions are the outcome of a solution of the problem of hydraulic compression prepared for my personal use, in an effort to co-ordinate the various requirements and physical features of the case. Similar, or perhaps identical, formulae may have been propounded elsewhere; they have not come under my observation.

A strictly analytical treatment of the subject would prove both a useless and a hopeless task: useless because to the man of action, for whom these notes are intended, the sight of a forbidding array of differential equations is a sure incentive to closing the book and dismissing a question presented in that shape; hopeless, because problems of that nature unavoidably involve some purely practical factors, our correct knowledge of which is at best very restricted. If they follow definite laws, these are still, to a large extent, enshrouded with uncertainty, and so long as the requirements do not trespass the limits of present practice, one must rest content for the time being with records of experiment and actual performance as a corrective to the common tendency to generalize unduly the results of limited observations. Such records are unfortunately scarce; too often inquiries of that nature are checked by commercial reticence.

The proposed line of computation assumes only an elementary familiarity with mathematics and physical mechanics; first using it as a checking process, it will be applied to the published results of elaborate tests conducted on a large and successful installation of hydraulic compressors; it next will be used for treating a special case in actual mining practice, the object being to impart an idea of the conditions under which a hydraulic plant deserves competitive comparison with the usual makes of air-compressor.

Again referring to Fig. 1, which indicates the general outline of a hydraulic compressor, air and water will be traced step by step during their passage through the machine, the following notations being used:

- p_0 = atmospheric pressure in pounds per square inch.
- p_1 = absolute highest air-pressure in pounds per square inch.
- Q = volume in cubic feet of free air available for useful purposes.
- c = volume in cubic feet of free air available for effecting compression.
- R = volumetric ratio of the total amount of entrained air to the volume of water.
- S = weight in pounds of one cubic foot of free air at pressure p_0 .
- V_1 = mean velocity in feet per second along induction-pipe.

INDUCTION COLUMN. Water from the fore-bay enters the induction pipe at its top, together with a certain volume of entrained free air, depending upon the velocity of the water. Various devices, which need not be

examined at this time, have been proposed for improving the entraining action of water on the air; it would appear that their main advantage consists in dividing that air into small bubbles, and thus facilitating cooling during compression, but the amount of entrained air is practically the same with or without these devices.

That fact was emphatically asserted by Frizell, and it is confirmed by more recent observation (Peele, 'Compressed Air Plant,' p. 245). At any rate, a mixture of water and of air bubbles is falling along the induction-pipe, the air being gradually compressed as the hydrostatic head increases with the distance below the level of water in the fore-bay. The entire amount of that air, however, is not available for useful purposes, because part of it becomes dissolved in the water.

The latter at saturation contains air to one-twentieth of its volume, irrespective of pressure. The result is that one cubic foot of water entering the induction-pipe contains in dissolution, and with no increase of volume $\frac{1}{20}$ cu. ft. of free air; but as the fall proceeds and that air becomes compressed, its volume diminishes, so that, in order to keep up saturation, the difference between $\frac{1}{20}$ cu. ft. and the actual volume occupied by the partly compressed air must be made up at the expense of the non-dissolved entrained air.

A steady and increasing drain therefore takes place on the initial volume of air, along the induction pipe, until the air and water mixture reaches the lower end of that pipe.

The 0.05 cu. ft. of free air held in dissolution at entrance has now become $0.05 \frac{p_0}{p_1}$ cu. ft. of compressed air at pressure p_1 and the drain on the entrained air, also measured in compressed state, is $0.05 \left[1 - \frac{p_0}{p_1} \right]$ cu. ft., corresponding to $0.05 \frac{p_1}{p_0} \left[1 - \frac{p_0}{p_1} \right] = 0.05 \left[\frac{p_1}{p_0} - 1 \right]$ cu. ft. free air.

In other words, if c cubic feet of water enter the induction-pipe in one second, the total volume of free air moving with it is Rc cu. ft., out of which the water holds in saturation $0.05c$, making the volume of entrained free air at entrance to induction.

$$Rc - 0.05c = c(R - 0.05) \text{ cu. ft. per second.}$$

When the mixture reaches the bottom of the induction-pipe, the drain on the entrained air to maintain saturation is, as above stated, $0.05c \left[\frac{p_1}{p_0} - 1 \right]$ measured in free air, leaving for useful purposes

$$c(R - 0.05) - 0.05c \left[\frac{p_1}{p_0} - 1 \right] \\ = c \left[R - 0.05 \frac{p_1}{p_0} \right] = Q$$

cubic feet of free air per second available for use, and therefore

$$R = \frac{Q}{c} + 0.05 \frac{p_1}{p_0}$$

The limits of available space and of the reader's forbearance would be exceeded by the tedious unfolding of simple calculations that leads to the following results:

Mean weight per cubic foot of mixture of air and water along the induction-pipe:

$$m = \frac{62.4 + 8(R - 0.05)}{2} \left[\frac{1}{1+R} + \frac{1}{1+R} \frac{p_0}{p_1} \right] \text{ lb.}$$

Mean volume of mixture passing per second through induction-pipe:

$$c_1 = \frac{c}{2} \left[1.9 + R \left(1 + \frac{p_0}{p_1} \right) \right] \text{ cubic feet.}$$

V_1 is, in feet per second, the mean net velocity of fall of that mixture, supposed to be constant along the induction pipe.

The corresponding diameter d_1 in feet is given by the relation

$$0.7854 d_1^2 V_1 = c_1 \text{ or } d_1 = 1.128 \sqrt{\frac{c_1}{V_1}}$$

Frizell states that small air-bubbles, say $\frac{1}{8}$ -inch diam.,

induce air by entrainment at the top of the induction-pipe to be 1 foot $= h_1$.

The entrance head, covering contraction is generally reckoned as one-half the velocity-head, or $0.0078(V'_1)^2 = h_2$.

The velocity-head $0.0155 (V'_1)^2 = h_3$.

The friction-head on the length H of the induction is $H \left(\frac{4 V_1^2 + 5 V_1 - 2}{14400} \right) = h_4$.

There is, besides, a loss due to the disruption, in the separation-chamber, of the induction-column moving at the assumed velocity (V'_1) . The corresponding head is $\frac{m c_1}{2g} (V'_1)^2$.

The net work done by the falling water is therefore

$$mc_1 \left[H - (h_1 + h_2 + h_3 + h_4) - \frac{(V'_1)^2}{2g} \right] \text{ ft. lb.}$$

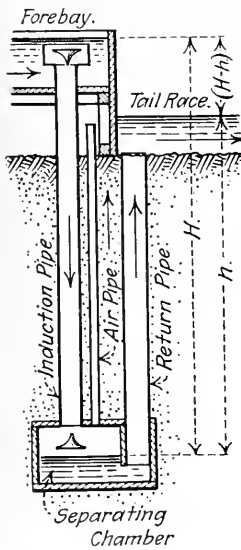


Fig. 1

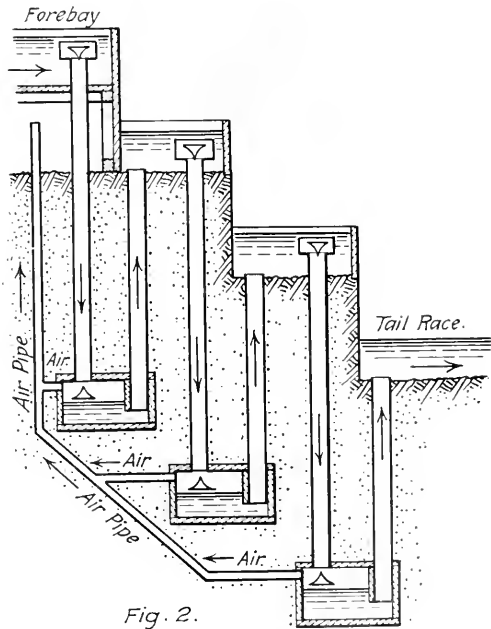


Fig. 2.

in suspension in still water, have a natural tendency to rise with a velocity of 0.8 ft. per second, varying as the square root of the bubble's diameter. And, therefore, if we assume that the compressed air at the foot of the induction-pipe is in the shape of small bubbles of that size, it will easily be found that the rising velocity at the surface would be $W_0 = 0.8 \left(\frac{p_0}{p_1} \right)^{1/2}$ feet per second, so that, while the net average velocity is V_1 its actual value at the top of the induction must be $(V_1 + W_0) = V'_1$, and as the velocity is supposed constant, this value must prevail along the induction.

The following portions of the total head are lost during the fall: Frizell estimates the necessary head to

RETURN COLUMN. When the mixture issues from the induction-pipe into the separating-chamber, the compression of the entrained air has been completed; the descending column meets a stationary shield that spreads it radially, at right angles with its former direction, and facilitates the separation of the air from the water. The former naturally seeks the upper part of the separating-room, where it enters the air-main. It is obvious that the larger this room is horizontally, the more complete will that segregation be, because the sudden increase of area brings the water to a comparative rest, and it abandons the entrained air-bubbles. The water remains saturated with air, and fills the lower portion of the room, where the submerged entrance to

the return-shaft is placed. The top of it opens in the tail-race, and its vertical depth determines the effective air-pressure.

The size of that ascending passage varies in the few existing installations of that type: it generally is a shaft, vertical or inclined, either enclosing the induction-pipe, or independent of it, but as a rule, of a materially larger cross-section. This, however, is not without exception: Kent (page 623) mentions an installation with a 3-ft. induction and a 4 ft. 9 in. return-pipe, and circumstances are readily conceivable where both may be laid on the inclined surface of the ground. If a is the uniform area of the return-passage in square feet, the mean velocity is $V_2 = \frac{c_2}{a}$ when c_2 is the mean volume in cubic feet per second of the ascending column of air and water.

If the return-passage is a circular pipe of diameter d_2 feet, then

$$V_2 = 1.273 \left(\frac{c_2}{d_2^2} \right)$$

Whatever be the sectional shape of the return-passage, d_2 may be taken as the diameter of an equivalent circular section.

The mean volume c_2 passing per second is

$$c_2 = c \left[1 + 0.025 \left(\frac{p_1}{p_0} - 1 \right) \right] \text{ cu. ft.}$$

The mean weight per cubic foot is

$$m_1 = \frac{62.4 + 0.05 \left(\frac{p_1}{p_0} - 1 \right)}{2} \left[1 + \frac{1}{1 + 0.05 \left(\frac{p_1}{p_0} - 1 \right)} \right] \text{ lb.}$$

The losses occurring during the return flow are represented by

$$a \text{ velocity-head } 0.0155 (V_2 - 0.8)^2 = h_v,$$

$$a \text{ friction-head } \frac{l}{d_2} \left(\frac{4V_2^2 + 5V_2 - 2}{7200} \right) = h_f,$$

when l is the actual length of the return-shaft in feet. The divisor 7200 applies to a rough shaft blasted out of the rock; with a smooth passage, that divisor should be 14,400.

$$A \text{ pressure-head } 2.31 (p_1 - p_0) = h_p.$$

And finally, the work of isothermal compression of Q cu. ft. of free air from p_0 to p_1 is $111 p_0 Q \log. \frac{p_1}{p_0}$ W.

The total resisting work is therefore $[m_1 c_2 (h + h_v + h_f + h_p) + W]$ ft. lb. and equating it to the net work done by the water:

$$m c_1 \left[H - (h_1 + h_2 + h_3 + h_4 + h_5) - \frac{V_1^2}{2g} \right] = m_1 c_2 (h + h_v + h_f + h_p) + W. \quad (1)$$

The efficiency of the process is the ratio of the useful work to the work of falling water, or

$$E = \frac{W}{62.4 c_1 (H - h)} \quad (2)$$

These two expressions furnish all the fundamental data necessary for an installation of hydraulic compression to meet given conditions. The manner of using them will now be exemplified on an existing plant erected in 1906 at the Victoria copper mine, near Rockland, in Ontonagon county, Michigan, the description of which can be found in Peck's 'Compressed Air Plant,'

pp. 242, *et seq.*) and in an article by C. H. Taylor in the MINING AND SCIENTIFIC PRESS of August 18, 1906.

The plan will ultimately comprise three identical units, one of which was in operation when tests were conducted by Prof. F. W. Sperr in May 1906.

Their results, published in the above papers, present slight discrepancies of pressure in connection with the dimensions given in the two descriptions, but that does not affect the result in view, namely, the concordance of the actual data with the above formulæ.

The results of the tests are as follows, in one of three cases:

Atmospheric $p_0 = 14$.

Absolute air-pressure $p_1 = 128$.

Cubic feet free air per second $Q = 198.83$.

Cubic feet water per second $c = 247$.

Diameter of induction $d_1 = 5$ ft.

Working-head $H - h = 70$ ft.

Return-shaft 540 ft. long = l , 10 by 10 ft. (?) with a 2-ft. air-main concreted.

Efficiency $E = 0.8227$.

Assumed temperature $60^\circ \text{ F. } S = 0.0726$.

Applying the previous formulæ, the results are

$R = 1.262$.

$m = 41.273$.

$c_1 = 407.55$ cu. ft.

$m_1 = 53.396$ lb.

$C_2 = 297.28$ cu. ft.

$W = 887,061.75$ ft. lb.

The value of the main velocity V_1 is arbitrary, and lacking a definite law of correlation between that element of the question and the volume of entrained air, one may safely assume that they vary in the same direction, as also do the inertial and frictional resistance, while the size and the cost of the induction-pipe becomes less.

Ivens ('Pumping by Compressed Air,' p. 124) mentions a lift of 840 ft. with a maximum velocity of 22 ft. per second in the eduction-pipe. This has reached 25 ft. in other cases.

In the present instance, a 5-ft. induction-diameter gives

$$V = \frac{c_1}{19,635} = 20.756 \text{ ft.}$$

and assuming the same value, for the sake of comparison, with

$$W_v = 0.8 \left(\frac{p_1}{p_0} \right)^{1/2} = 1.157 \text{ ft. sec.}$$

as the rising velocity at surface, $V_1 = 21.913$ ft., and therefore $h = 1$; $h_2 = 7.443$; $h_3 = 3.721$; $h_4 = 0.025 H$; and $\frac{(V_1)^2}{2g} = 7.113$, making the net work of water $16,820.81 [0.975 H - 19.607]$ ft. lb.

The width of the return-shaft, not given, is assumed equal to its height, namely, 10 ft. Concreting of the 2-ft. air main occupies 3 by 3 ft., = 9 sq. ft., leaving a net area of 91 sq. ft. with an equivalent diameter of 9.52 feet.

The mean velocity in the return-shaft is

$$V = \frac{c_2}{a} = 3.267 \text{ ft.}$$

and therefore $h_5 = 0.0155 (3.267 - 0.8)^2 = 0.092$ ft.

$$h_6 = \frac{540}{9.52} \times \frac{57.027}{7200} = 0.449 \text{ ft.}$$

$$h = \text{as per descriptions} = 272.000 \text{ ft.}$$

$$h + h_5 + h_6 = 272.541 \text{ ft.}$$

Equation (1) becomes

$$16820.81 [0.975 H - 19.607] = 15873.56 \times 272.541 + 887061.75.$$

$$H = 337.99, \text{ say, } 338 \text{ ft.}$$

and subtracting working-head 70 ft.

the pressure-head is 268 ft.

The efficiency is 0.823.

As a matter of fact, the value of H in the Victoria plant is 342 ft., with a pressure-head of 270 ft., a working-head of 72 ft., and an air-pressure of 117 lb., instead of 114 lb. given in the test's records. A shorter length of the total head H was therefore to be expected with the present data, and the above results established the practical conformity of the proposed solution with actual facts.

Another application will now be considered to the case of a mine where the available supply of water is scant, compared with the required amount of air.

The data furnished by the inquirers are

Altitude = 10,000 ft.

Temperature from + 90° to - 25° F.

Minimum flow of water = 500 mi.

Volume of free air required for use = 2000 cu. ft. min.

Effective air-pressure per square inch = 100 lb.

The site makes it desirable to avoid, if possible, the use of heavy machinery and the necessity of important repairs.

An assumed repartition of temperature throughout the year places its mean value, between the mine and sea-level, at 48° F. and this gives

$$p_o = 10.156; p_i = 110.156; Q = 33.33; S = 0.054;$$

$$c = 12.5; \frac{Q}{v} = 2.6664; R = 3.209.$$

A series of calculations entirely similar to those used in the previous example give the following results:

Diameter of induction-pipe, 20 in.

Mean velocity in induction-pipe, 15.47 ft. sec.

Diameter of return-pipe, 28 in.

Mean velocity in return-pipe, 3.64 ft. sec.

Total height, $H = 310.86$ ft.

Working head, $H - h = 79.86$ ft.

Efficiency of the process, $E = 1.863$.

This means an impossibility.

Now, an ordinary air-compressor, operated by a water-wheel, would meet the present requirements, at a total efficiency of 55%, with a working-head of 271 ft. In a general way, it is true to say that theoretically any definite amount of water will perform any definite amount of work under a sufficient head. Nor does the rule suffer exception in the case of hydraulic compression; the recorded impossibility is chargeable, not to the system itself, but to the imposed combination of volume and pressure of the air.

The following results would be found, for the same volume of air and water as assumed in the last example:

Effective air-pressure (lb. per sq. in.).	50	25	8
Total head, H ft.	216.7	148.99	82.38
Working head, $H - h$ ft.	101.2	91.24	63.9
Efficiency	1.098	0.854	0.567

It appears therefore that under given volumetric conditions of air and water, there is a certain pressure corresponding to the maximum efficiency, the upper limit of which is necessarily below unity, on account of the loss incurred from the compression of the saturating air.

In mining, pressures of 100 lb. or thereabouts are generally desired for operating machine-drills. Lower pressures may, however, be useful, for instance, as sometimes suggested, to furnish the first stage of compression for a compound-piston machine; this would permit an ordinary one-stage compressor to perform the finishing stage to 100 lb., a result that could not economically be obtained in a single cylinder.

Another valuable use of low pressures is the operation of serial air-lifts, which only can be mentioned at this place. If, however, an effective pressure of 100 lb. is considered imperative, a hydraulic installation becomes possible by fractioning the plant into several consecutive units acting in parallel so far as air is concerned, and in series for the use of water; in other words, the same water is used several times in succession to produce a cumulative amount of air, the scope of the combination being only limited by the total available fall, controlled, of course, by considerations of economy.

Here are some results of such an arrangement. (Fig. 2.)

Effective air-pressure per sq. in.	100	100
Cubic feet of water per minute.	750	750
Cubic feet of free air per minute at each stage.	1000	800
Number of serial stages.	2	2.5
Total height, H ft.	315.45	304.47
Working head, $H - h$ ft.	84.45	73.48
Efficiency	0.881	0.811

It appears, therefore, that the hydraulic system of compression is adaptable to a variety of forms, under a high efficiency; it is, however, safe to say that its best field of application is characterized by large volumes of air and of water, and that, when their ratio, in the order here named, materially exceeds the unit, a mechanical installation seems, at first glance, more satisfactory.

The problem involves, however, too many conflicting factors to warrant rigid rules of limitation. One unique feature of this type of compressor is that it can be established in a case of emergency when more elaborate machinery would be altogether out of question; and in a remote locality, it may, on that account, prove extremely valuable.

DAMASCUS STEEL, famous throughout the world, owes its peculiarly valuable qualities to the fact that it contains tungsten, according to Duc de Laynes, who published something on the subject in 1844.

The White Caps Mine, Manhattan, Nevada

By John L. Dynan

The White Caps mine is at Manhattan, Nevada, 45 miles north of Tonopah, and has been operated intermittently since 1905. Recent discoveries of good ore on the 300-ft. level have revived interest in this long neglected, although promising, mining district.

Oxidized gold ore was discovered on the surface of the White Caps claims, and an incline-shaft was sunk to a vertical depth of 200 ft. Water-level was at 150 ft., and below that point the ore changed to massive sulphide. The oxidized ore can be readily cyanided, while the sulphide ore is not amenable to direct cyanidation.

In 1912 a party of lessees erected a mill and cyanide plant of 75 tons daily capacity. For a time a good production was made, but when the oxidized ore was exhausted the mine and mill were closed, except for a few shipments, to smelters, of selected high-grade sulphide ore. A process has been designed recently for treating the sulphide ore by roasting and cyaniding, and a roaster

It is to the third type that the White Caps orebodies belong. The ore is a replacement of limestone by quartz, pyrite, arsenopyrite, and stibnite. Calcite, due to recrystallization of the limestone, is abundant. Realgar is common, and cinnabar occurred in small quantities above



FIG. 1. PLAN OF ORE-SHOOTS ON THE 200-FT. LEVEL.

is now being added to the mill. Details of the treatment will be given at some future time, after the mill has been in operation.

The mine is now operated through a vertical two-compartment shaft, sunk in the hanging wall of the orebodies. There are levels at 100, 200, and 300 ft. The total production to date is 19,909 tons of ore, assaying \$19.14 per ton in gold, or \$381,053 gross. This was almost all oxidized ore from above the 200-ft. level.

The sedimentary rocks of the region were originally shale and limestone, which have been intruded by a large mass of granite. The granite outcrops two miles south of Manhattan, also four miles north, and probably underlies the whole district. Later flows of rhyolite cover much of the surface. The sediments have a north-west strike, and dip 55° south west. Metamorphism has been widespread, changing the shale to schist, or quartzite, and altering the limestone to coarse calcite.

The ore deposits occur in the sediments, and are of three types, as follows: (1) Small gold bearing veins, with a gangue consisting principally of quartz and calcite; (2) Low-grade disseminations of free gold through out the cleavage-planes of the schist; and (3) Replacement deposits in the limestone.

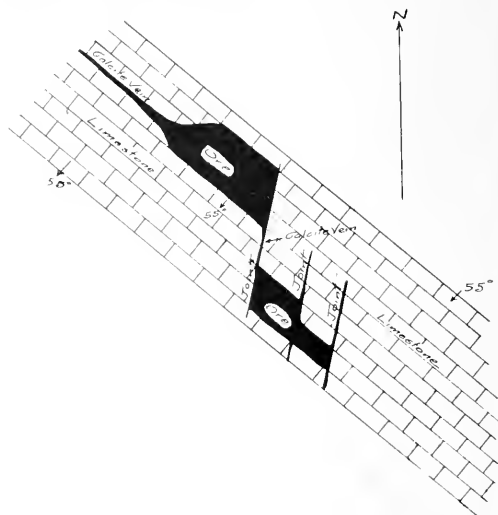


FIG. 2. SKETCH-PLAN SHOWING ORE-SHOOTS IN THE LIMESTONE.

the 200-ft. level, but has not been found below it.

An analysis of typical ore is given:

	%		%
SiO ₂	55.8	Sb	0.7
Al ₂ O ₃	1.8	As	1.5
CaO	7.2	MgO	3.2
Fe	8.9	H ₂ O	0.8
S	8.2	CO ₂	9.2

Gold, 1.02 oz. per ton; silver, 0.02 oz. per ton.

This corresponds roughly with the following mineralogical composition:

	%		%
Pyrite	13.8	Calcite	19.6
Arsenopyrite	3.3	Quartz	52.0
Stibnite	1.0	(Ca, Fe, Al) silicates	7.4

Typical ore has much the same appearance as the hard blue limestone of which it is a replacement. Upon close inspection, however, its silicious nature is apparent. The pyrite and arsenopyrite are fine-grained. The characteristic odor of arsenic can be detected upon striking the ore with a pick. Stibnite is found in prismatic and radiating needles and often forms bunches up to four inches in diameter. Samples of ore occasionally assay as high as 8% antimony. Calcite occurs in coarse crystals, and its presence in the limestone is a good in-

dication of the proximity of an ore-shoot. Veins of pure white calcite are frequently followed until they lead to ore.

Realgar is usually found as a thin film coating calcite crystals, or in cracks in the limestone. It also occurs in the shale hanging wall, three or four feet above the ore. Sometimes it forms a film two or three feet square on some smooth surface, and then presents a beautiful appearance. Probably the realgar is a secondary mineral derived from the arsenopyrite.

Cinnabar has been found in small quantities above the 200-ft. level. Its resistance to oxidation made it particularly conspicuous in the oxidized zone.

The condition in which the gold occurs is not known. The sulphide ore, in its raw state, is quite refractory to cyanide treatment, and some of the tests made on it showed identical gold content in heading and tailing

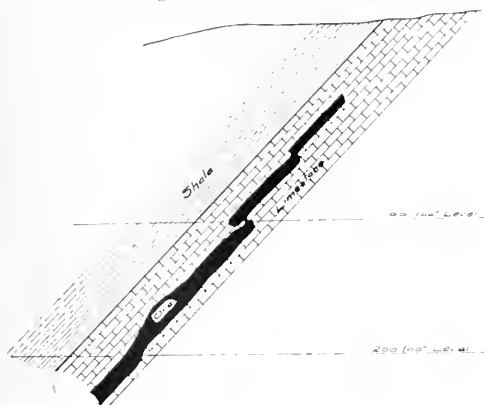


Fig. 3. SECTION THROUGH THE WEST ORE-SHOOT.

samples. The oxidized ore can be cyanided readily, with 90% extraction, and the same is true of the sulphide ore when roasted under special conditions. The gold evidently is in such form that heat or oxidation sets it free. It may be present as a telluride, although no tests sufficiently delicate to determine this have yet been made.

Two principal ore-shoots, known as the East and West, respectively, have been discovered to date. They are separated by a fault, called the White Caps fault, which is older than the ore. A third ore-shoot, less important, occurs along this fault. This is called the shaft orebody, from an old incline, now abandoned, which followed the ore from the surface to the 200-ft. level. The relation of these orebodies to each other, and to the surrounding rocks, is shown in Fig. 1, which is a sketch of conditions on the 200-ft. level.

The limestone in which the ore is found is a hard compact rock of dark-blue color. Its thickness is from 20 to 100 ft. It strikes north-west and dips 55° south-west. The bedding-planes are well defined and average four feet apart. A conspicuous system of joints strikes N 10° E and dips 70° east.

Above this limestone is a thin-bedded shale, called the hanging-wall shale. Below the limestone is the foot-wall

shale, of the same character as the other. Both these shales pass into limestone, becoming more calcareous as they approach it. The exact line of contact is often obscure.

The chief importance of the shales is that they have formed impervious barriers to the solutions which deposited the ore. Calcite veins occur in both the upper and lower shale, but they are small and non-persistent. Numerous faults are exposed. The principal one is the White Caps fault, which strikes west and dips south 60°. On the 200-ft. level, the horizontal displacement is 300 ft. It is marked by a dark-blue gouge from six inches to four feet thick. Faults transverse to the strike of the orebodies are numerous, but they are usually of small displacement. There has also been movement parallel with the bedding of the shale, and both hanging-wall and foot-wall shales contain numerous interbedded layers of gouge, up to six inches thick.

This mine affords an excellent example of the influence of structure upon ore deposition. The ore-bearing solutions have, of course, been confined to the limestone by the impervious shale strata lying above and below it. Within the limestone itself the bedding-planes and joints have a marked effect upon the distribution of the ore. An important ore-shoot will frequently start as a thin seam of calcite along a bedding-plane. Upon driving on this seam, it gradually widens to a calcite vein, from four to five feet wide, and may finally make an orebody as much as 20 ft. wide, with coarse calcite scattered through it. The ore will then stop abruptly against a strong joint or cross-fracture; this joint is frequently filled by another calcite veinlet, and by following this another ore-shoot may be found on some other bedding-plane. Two or three stopes are sometimes superimposed, each ore-shoot following its own bedding-plane, being separated from the others by barren limestone. Fig. 2 is a generalized sketch showing the conditions described above, and Fig. 3 is a section through the West ore-shoot.

There is little doubt that the ore owes its origin to solutions emanating from the intrusive granite. The contact, however, is remote from the orebodies, and contact minerals have not been found in the White Caps mine. Near the contact south of the town, however, coarse calcite and garnet have been found in the sediments, and assays of some of these specimens showed 0.03 oz. gold per ton.

PETROLEUM PRODUCTION in Wyoming at present approximates 31,000 bbl. daily, distributed as follows: Moorcroft field in Cook county, 250 bbl.; Big Muddy, in Converse county, 500 bbl.; Salt creek in Natrona county, 15,000 bbl.; Lost Soldier, in the extreme north-east corner of Sweetwater county, 250 bbl.; Spring Valley, in southern Uinta county near Evanston, 150 bbl.; Pilot Butte, in Fremont county, 100 bbl.; Grass creek, 6000 bbl.; Elk Basin, 4000 bbl.; Gray Bull, 500 bbl.; and Warren, 4000 bbl. The last four fields are all in Big Horn county. The Warren field is just over the line from the Montana boundary.

Cheap Mine Ventilation

Mine ventilation is most important. Metal mines are usually well ventilated throughout the main workings, but distant drifts, raises, and dead-ends generally fail to get sufficient fresh air. In most cases these poorly-ventilated places may get a fair share of fresh air if the circulating air-currents are not cut off or short-circuited. The remedy lies in placing doors at proper places so as to cause the air to pass along to the most remote workings of the mine instead of taking the shortest way out to the surface, as it naturally will if not diverted. When natural ventilation fails, blowers or fans of some description are generally utilized to send the pure air where needed. At some mines the water-blast is used effectively and may be employed at any mine where suitable conditions exist. The essentials are a few inches of water that can be allowed to fall into a vertical box or pipe 10 or 12 in. in diameter, through a height of 30 ft. or more. The water entrains air as it falls and this air is collected in a closed chamber above the water-level and at the foot of the pipe. From here it is conducted by pipes into the mine-workings. An arrangement such as described will send a good volume of air through an 8-in. pipe to a working-face several hundred feet distant. When the water costs nothing the expense of ventilation by this method is merely the cost of the simple equipment at the surface and the pipes leading into the workings.

Where water is not available for use as above described, cheap ventilation may be secured by several other methods; for example, the placing of a wind-sail on a light wooden frame at the surface, so constructed that a current of pure air may be sent into the mine through a pipe by the force of the wind blowing against the sail. The sail should be triangular in shape, 6 ft. broad at the top and 6 ft. long, converging to a funnel-shaped opening at the bottom, which is secured to the top of the pipe. The sail should be so arranged that it can be turned to face the wind. A strong wind directed in this manner will serve effectively to ventilate many hundred feet of mine-workings.

Another device is the stove or furnace, built at the opening to the mine and so arranged that the supply of air must come from the workings through a pipe carried to a point near the face of the drift, or bottom of the shaft. This device exhausts the foul air from the mine, a current of pure air from the outside flowing through the workings to replace the impure air passing out through the pipe. There is no better material for ventilation-pipe than galvanized sheet iron, which, though more expensive in first cost, will not corrode, and therefore is more economical than plain sheet iron. A box-pipe made of lumber will answer the purpose, but it must be made tight its entire length, particular attention being given the joints.

A tightly-covered drain, beneath the floor of the adit or drift, has been successfully employed for ventilation, while serving at the same time as an exit for water. In this case the flow of the stream of water facilitates the

passage of the air. Any miner with a little ingenuity and mechanical skill can make any of these arrangements at little cost of labor and materials, and the result will well repay such expense, as he can then work in a fairly pure atmosphere, and there will be a minimum of lost time in clearing the workings of smoke and gas after blasting.

Tank Construction

Leaching-tanks should be made of clear lumber, red-wood or Oregon pine being best for the purpose. Circular tanks are preferred for permanent plant, though those of square or rectangular section are frequently used. The tank should rest on sills, and, if possible, these should be supported on posts sufficiently high above the ground to admit of easy passage beneath the tank to stop leaks, or to make repairs. Rectangular tanks should be braced with 2 by 6-in. posts mortised into the sills and strengthened with horizontal iron bolts so that the sides may be drawn tight. Upright bolts are also advisable for the same purpose. Tanks of large sectional area are preferable to smaller ones as it is proportionately less expensive to treat a large than a small charge. Ordinarily the rate of leaching is not increased by depth, therefore comparatively shallow tanks are better, leaching being facilitated by greater superficial area rather than by a deeper charge. It is the practice to sluice out tailing when water is abundant, otherwise the tailing must be shoveled out.

False bottoms are usually constructed of slats $1\frac{3}{4}$ in. high and 1 in. wide, spaced 1 in. apart. They are generally screwed to the bottom of the tank, though sometimes the slats are made in two semi-circular segments so constructed that they may be taken up and removed from the tank. The under edge of the slats should be provided with numerous notches which will permit a free passage of solution toward the outlet of the tank. An annular space is also left between the edge of the tank and the false-bottom. The filter of cocoa-matting is laid on the slats, the superficial area of which coincides with the false-bottom, and this is covered with heavy drilling or light canvas (generally 10-oz. duck) cut in circular form and of a diameter 6 in. greater than that of the tank. The edge of the canvas is forced down and the filter secured in place by calking in a piece of $\frac{1}{2}$ in. manila-rope, just long enough to conform to the inside circumference of the tank. The outlet for the solution should be made in the bottom. This opening is covered with a block of wood 3 in. thick and having a hole bored through it at an angle of 30°. Through this hole a rubber hose is drawn; a flange-coupling being used to make a close fit. If tailing is to be sluiced out, a gate 18 to 20 in. wide and 10 in. high should be provided in one side of the tank, the bottom of which is flush with the top of the filter. In tanks of 150 tons capacity, or larger, the discharge-gate is generally placed in the bottom of the tank. In either case care must be taken in construction to prevent leakage.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

ALASKA

The Secretary of the Interior is asking Congress to appropriate \$10,590,672 for next season's work on the railway. Last year \$6,247,620 was voted. Plans were submitted for 240 miles of line to be constructed.

JUNEAU. October returns of the mines on Douglas island were as follows:

	Alaska Mexican	Alaska Treadwell	Alaska United
Stock of broken ore, decrease or increase, tons	-11,237	-16,107	+19,618
Ore crushed, tons	12,635	26,362	48,734
Gold yield	\$14,926	\$56,262	\$66,153
Yield per ton	1.18	2.13	1.35
Operating profit	516	25,320	.....
Construction charge	5,045	16,736	15,003
Loss	4,529	.....	7,704
Other income	3,784	11,521	3,881
Net value of copper plates	.....	32,518	37,567
Total profit	.....	\$52,623	.....

At the Mexican mill amalgamation has been discontinued, and all the gold recovered from concentrate. Treatment of copper plates at the other mills continues.

ARIZONA

GLOBE. The New Dominion Copper Co. is preparing to commence shipping ore mined by lessees. The carbonate ore averages 8%. The shaft is timbered to a depth of 250 ft. Nearly 30 men are employed.

JEROME. Diamond-drilling from the 1400-ft. level of the United Verde Extension may be done to prospect the adjoining Jerome Verde property.

TUCSON. The Tucson Arizona Copper Co. has been organized by J. F. Cowan of Salt Lake City with a capital of 1,000,000 \$1 shares. Auto-trucks are to haul ore to the Sascos smelter at an early date. Sixty men are to be employed for a start.

CALIFORNIA

(Special Correspondence.)—At the Rand mine on Slickrock creek, 8 miles north-east of this place, the south adit has been put in 65 ft. The pay-ore continues for 25 ft., beyond which there is little value. On the north side of the creek an adit was driven 40 ft., showing a little scheelite. A shaft, sunk in the open-cut at the mouth of the south adit shows good ore—7 to 9% WO₃. The ore on the dump is valued at \$50,000. It will be concentrated to 35% for shipment. There is a good prospect of scheelite on the C.O.D. claim on Cedar creek, two miles north of the Rand mine.

Glenville, December 6.

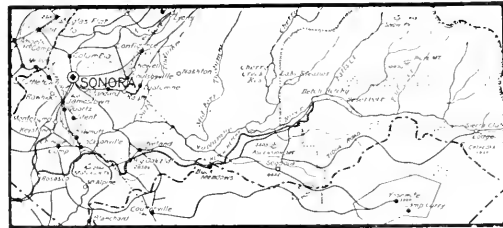
GRASS VALLEY. The Grass Valley Boundary Mines Co., organized by M. J. Brock, is to develop the Oak Tree, New Idea, and Cabin Flat claims under part of the town. About \$10,000 is to be spent.

The Empire mine has 80 stamps crushing ore, and the monthly gold yield is reported to be \$120,000.

OROVILLE. The Federal Government has approved of the new concrete restraining dam across Slate creek, and hydrau-
licdrainking will be started on a large scale at St. Louis and Howland's Flat in the spring.

(Special Correspondence.)—The bonding of the Harvard

mine to W. J. Loring is regarded locally as one of the most important deals that have ever been consummated in Tuolumne county. It is understood that the property, if the examination proves satisfactory to Mr. Loring, will be operated under the same management as the App. Dutch, and Sweeney mines. This transaction, together with the recent acquisition of the Rawhide and other properties by the Silver Peak Mining Co., and the report that the Guggenheims have representatives investigating this field, gives rise to the belief that the county is to benefit considerably. The new flotation plant at the Dutch mine, which was installed by Minerals Separation was given a thorough test this week and proved a success. Its



PART OF TUOLUMNE COUNTY, CALIFORNIA.

capacity is 250 tons daily. Many mining men of the county have inspected the new plant, and as the initial test has given satisfaction, it is likely that flotation will be adopted by other mines.

Additional pumping machinery is to be installed at the Rawhide.

The old adit at the Ocean Star, formerly known as the Duffield, has been repaired, and will be driven 300 ft. in the hope of cutting the lost vein. Over \$250,000 was extracted from the property prior to the time the fault was encountered, a number of years ago. Attempts to find the lost vein have failed so far.

In a statement of the financial affairs of the Nyman Consolidated Mines Co., which recently acquired by purchase the Santa Ysabel mine, it is stated that the Knox and Boyle vein yielded \$3000 during October.

The Deep Channel Mining Co., in which several Los Angeles men are financially interested, will at once commence prospecting operations with a drill on its holdings in the Confidence section.

Sonora, November 30.

COLORADO

CRIPPLE CREEK. The November gold output, as reported by the mills and smelters, was as under.

Golden Cycle	38,000	\$19.00	\$722,000
Portland	11,333	19.85	223,969
Portland	18,700	2.51	45,937
Smelters, Denver and Pueblo	4,550	55.00	250,250
Isabella	2,640	3.00	7,920
Worcester-Rubie	400	3.20	1,280

Total 75,023 \$16.54 \$1,311,356

GEORGETOWN. As treatment tests on dump ore of the Colorado Central Mining Co. have been satisfactory, plans for the

first 100-ton unit are being prepared. A rock-house of 500-ton capacity is to be erected also.

LEADVILLE. Below the 1200-ft. level of the Greenback shaft there is a large flow of water, taxing the pump's capacity to the limit. The cause of this flow is not understood.

The Jamie Lee shaft on Fryer hill, has been drained and the H. S. S. R. & E. Co. is preparing to deepen it. All the mines in this group have been connected to the air-compressor. Zinc carbonate is being extracted from the Tip Top shaft.

IDAHO

ELK CITY. Considerable new work is being done in this district, especially at the Mineral Zone and Black Pine mines. Seattle people have bonded the Mother Lode and other claims for \$25,000.

MULLEN. The Federal M. & S. Co. is to complete enlarging its Mammoth mill early in February; the capacity will then be 2000 tons daily at this and the Morning mill. Except that of the Bunker Hill & Sullivan the Morning mine will have the largest plant in the Coeur d'Alene.

MURRAY. Shortage of water and other troubles have caused a suspension of work at the Golden Chest gold-tungsten mine for the winter. It is probable that a new mill may be erected.

PINE CREEK DISTRICT. The Highland-Surprise company expects to pay dividends at an early date. There is 160,000 tons of zinc-lead ore blocked out. The smelter contract has been revised to advantage. The mill is doing good work in charge of T. Owens. Flotation is part of the process.

MISSOURI

CHADWICK. The old Casey Roberts mine, near here, in Christian county, has been re-opened recently by the Hobart-Lee Tie Co., of Springfield, and shipments of lead ore have been commenced to Joplin. Chadwick is 75 miles east of Joplin and 25 miles south-east of Springfield. This property has been idle since the Civil War, prior to which Christian county was a scene of mining activity, when both lead and zinc ore were mined in large quantity. A man named Gibbs undertook to work the mines many years ago and was found dead in the workings, the physicians said of heart failure, but the miners attributed his death to supernatural causes and refused to work in the mine, since which time nothing has been done until this new company took hold of the property.

JOPLIN. Zinc-ore prices were unchanged last week, though firm. Lead advanced slightly. The Empire District company's electric plant at Riverton had a break-down, resulting in curtailment of ore production. The output of the region was 9208 tons of blende, 446 tons of calamine, and 1390 tons of lead, averaging \$99, \$54, and \$89 per ton, respectively. The total value was \$1,050,845.

MONTANA

BUTTE. The increased price of spelter will make a big difference to Butte & Superior's earnings.

The Bullwacker lessees are to ship 100 tons daily to the Garfield smelter in Utah. November profits were \$11,800.

In the Main Range mine of the Tuolumne lode is 39 ft. wide, assaying 8% copper and 16 oz. silver across 15 ft. and 1% and 6 oz. across the remainder. Boilers and a pump are to be installed.

During the third quarter of 1916 the Davis Daly Copper Co. made a loss of \$2111. The revenue totaled \$107,619. The copper output was 679,098 lb., and silver 57,069 oz. It is said that Butte people are buying shares all the time. About 1/2 of the property is in the zinc area and 1/2 in the copper zone, and future development is expected to reveal considerable ore bodies. High-grade glance and hornite was cut at 2100 ft. last week. This is the lode worked on the 2000 ft. level.

Thirty tons of 90% copper concentrate has been sent to Anaconda by the Butte-Duluth company.

NEVADA

GOLDFIELD. To develop ground adjoining the Goldfield Consolidated and Florence Goldfield, the Red Hill Florence Mining Co. has been organized, being a consolidation of the Red Hill and Florence American companies. No work has been done by the last mentioned for a long time, owing to there being no money for this.

LOVELOCK. At the Lovelock Quicksilver Co.'s mine a 5-ton furnace is producing 10 flasks of mercury each week. The property is at Antelope Springs.

The new mill of the Humboldt County Tungsten Co. at Toulon is yielding one ton of concentrate daily, containing 70% WO₃.

RAND. A report has been made by C. R. Murdoch on the Nevada Rand Mines property, in Mineral county, 15 miles from the railroad station at Rand, or midway between Tonopah and Wonder. The rocks consist of andesite, dacite, and rhyolite; the ore occurs chiefly on the foot-wall and along cross faults. Associated with the gold-silver ore is manganese oxide, characteristic of the district. The ore is oxidized to a depth of 250 ft. The formation is wide, and the pay-ore is confined to a vein from 1 to 3 ft. wide, with lenses up to 8 and 10 ft. A shaft has opened the ground to a depth of 250 ft. Some high-grade shoots have been opened, that between 150 and 250 ft. has been extracted. Some good ore still remains; also a surface dump of 1200 tons of \$15 material. The mine is capable of further development, and is fairly well equipped.

THOMPSON. Ore, coke, and supplies are being taken to the Mason Valley smelter, which is expected to start again early next year.

TONOPAH. Last week the district's output was 9952 tons of ore worth \$195,076.

The old Tybo mine in Nye county has been leased for 20 years to the Louisiana Consolidated Mining Co. of New York. J. B. Farish made a report on the property for Baruch Bros. Hoisting and pumping equipment is to be installed.

VIRGINIA CITY. On December 6 pumps started lowering water to the 2900-ft. level of the Comstock. A review of work done on the lode during 1916 is as follows:

(1) Opening of the Union shaft from the 2000 to the 2700-ft. level, making it the deepest vertical shaft operating in Nevada. This cuts out a long haul of nearly half a mile through the drifts, and in addition greatly helps the ventilation. (2) Opening of the Union and Sierra Nevada winze from the 2500 to the 2700-ft. levels and the additional discovery that it is in good condition to 2900 ft. (3) The purchase and installation of pumps in the Mexican-Ophir winze, which have now commenced work, and will drain the North End mines to the 2900-ft. level, opening ground that has been flooded for over 30 years. (4) A great improvement in ventilation which has made work at every point underground easier and cheaper. (5) The discovery of ore in Union, which has placed that mine in better financial condition than for 36 years. (6) The repairing of the Ophir shaft, the up-cast shaft of the North End mines, thereby protecting them from any interruption of ventilation, and the enlarging of drifts that carry the air in many places. And (7) the commencement of work at the Combination shaft, which means active mining in the middle group, the centre of the Comstock lode.

OKLAHOMA

CARBON. The mill that was moved from Reeds, Missouri, to the U. S. Mining & Smelting Co.'s mine here, has been finished, with a capacity of 300 tons daily. Coal is used for fuel. The ore is all of high grade, and occurs in flint formation at a depth of 200 feet.

MIAMI. The largest operator here is the Commerce Mining & Royalty Co. A 150-ton mill is at work on its Turkey Flat, and one of 250 tons' capacity on the Blue Goose. A 300-ton

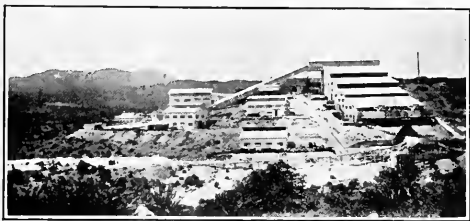
plant is being erected near that on the latter. In storage the company has about 4000 tons of zinc-blende for sale.

Another large producer is the Miami Zinc & Lead Co., which has two mills, one of 250 tons, the other of 300-ton capacity. The largest pump in the Missouri-Kansas-Oklahoma region is being worked. It is a 16-in. Prescott make, pumping 2500 to 3000 g.p.m. from a depth of 380 ft., draining the entire Commerce field.

NEW MEXICO

MOGOLLON. An initial dividend of 1% has been paid by the Oaks Company. Similar monthly distributions are to continue.

The Mogollon Mines Co. treated 4000 tons of ore in November.



HURRO MOUNTAIN COPPER CO.'S MILL AT TYBONE, NEW MEXICO.

SANTA RITA. Among the dividend-payers of December, the Chino Copper Co. will distribute \$2.50 per share.

OREGON

RIDDLE. The Eldorado Copper Mining Co., capitalized for 2,000,000 shares at \$1 each, has been organized by Spokane and Oregon men to take over and operate the Banfield copper mine, 32 miles east of this place, on the main line of the Southern Pacific railway. The reported price is \$300,000, part cash and the remainder shares in the new company. The incorporators are Andrew Laidlaw and S. W. Miller, of Spokane, and others. The Banfield mine is one of the best known copper properties in Southern Oregon, and many well posted mining men regard it as the largest high-grade copper deposit in the State.

SOUTH DAKOTA

The statistical branch of the U. S. Geological Survey has issued its report of mineral production for South Dakota and Wyoming in 1915. It shows that in 1915 there were 33 mines operating in the Black Hills, in South Dakota, producing 1,889,975 tons of ore, having a value of \$7,406,305 in gold and \$101,331 in silver. The production of lead was only 3107 lb., worth \$146. This output shows an increase of \$76,439 over the production of 1914.

In the Black Hills, the Homestake was the principal producer, as it always has been. The total production of gold in the Black Hills from the discovery of the placers in 1875 to the end of 1915 has been \$192,693,945, and of silver \$4,315,005, a total of \$197,008,950. The production of placer gold in the Hills, which in the early years of the country—from 1876 to 1880 amounted to millions of dollars—in 1915 was but \$1589.

Wyoming, in 1915, mined 4216 tons of ore, which produced gold valued at \$14,592, silver \$426, and copper 447,246 lb., worth \$78,268, a total of \$93,286, which was an increase of \$85,899 over the output of 1914.

LEAD. The Homestake Mining Co. has posted the following notice: "The Homestake Mining Co. will pay to all employees whose names appear on the December 1916 pay-roll, additional wages amounting to 7% of the year's salary for 1916. Checks for same will be given out on the January pay-days."

UTAH

FAUST. Fifty miles north-west of this place, which is on the Salt Lake Route, is the Dugway district, which is said to be fairly active. A number of properties are giving gratifying results, some shipping ore. The ores contain lead and copper.

PARK CITY. On December 30 the Silver King Consolidated pays 15c. a share, equal to \$95,250. This makes a total of \$285,750 for 1916. The daily output is 50 tons of \$45 to \$65 ore; a recent shipment netted \$63. Ore comes mostly from a depth of 1500 and 1650 feet.

On January 1 the Silver King Coalition pays 15c. a share, or \$187,500. This makes \$750,000 in 1916. The weekly output of crude ore and concentrate is over 500 tons.

The Judge Mining & Smelting Co. pays 25c. per share on the 20th. This is equal to \$120,000, and makes \$435,000 for 1916.

SALT LAKE CITY. Affairs of the Ohio Copper Co. are still unsettled, and Utah shareholders are watching the decision of the U. S. District Court in the matter of the title being given to the Stockholders' Protective Committee, whose representatives in New York offered a check for \$1,350,000 to liquidate the bonded indebtedness.

Later advice: The Court has decided to allow of a reorganization of the Ohio Copper Co. Shareholders have subscribed for over \$500,000. The new company is to have 2,500,000 \$1 shares, \$50,000 to be held by the treasury.

During the 9 months ended October 1, 1916, the Utah Metal & Tunnel Co. and Bingham-New Haven Co. made a profit of \$567,737. The gross value of the gold-silver-lead-copper ore was \$1,262,752. The weight of ore and concentrate was 60,364 tons. Water sold realized \$37,162. Mining cost \$2.42, and milling \$1.01 per ton. On August 15 a dividend absorbed \$342,473. Development covered 10,190 ft., at \$10.45 per foot. Results were encouraging. The flotation plant started in October to treat tailing and low-grade copper-iron ore. Another crusher and ball-mill will add to the daily capacity 75 tons, making a total of 300 tons. The copper and lead has been sold for delivery during the first half of 1917. The bonded debt was reduced \$145,500, leaving \$229,500 outstanding.

TINTIC. November production of the Tintic district was 44,200 tons, valued at \$1,100,000. Last week was the heaviest for any period in 1916, namely, 13,000 tons. For 11 months the total is estimated at 416,100 tons, valued at \$10,000,000.

To open ore being mined at 1800 ft. depth, the Chief Consolidated contemplates putting in pumps and sinking. One of the difficulties in this district is the height that water must be pumped in order to get it to the surface.

From December 1, Tintic mine-owners are to pay miners and others 25c. per day extra. Miners will get \$3.75, machinemen \$4, shaft-men \$4.50, and shovelers \$3.50 per shift.

The Colorado company is sinking its shaft from 1500 to 2000 ft. Walter Fitch is the contractor.

The May Day's upper levels are yielding 75-oz. silver ore.

WASHINGTON

CHEWELAH. On January 15 the United Copper Co. distributes 1c. a share, or \$10,000. A shaft is to be sunk from the 1000-ft. level, where the ore-shoot is 1300 ft. long and 8 ft. wide. A. McDonald is now superintendent.

NORTHPORT. During the four months ended October 31 the Electric Point mine shipped 151 carloads of ore. The carbonate ore averaged 22.89%, and the sulphide 71.47% lead. Receipts were \$90,602, not including settlements on 43 carloads. This is a new mine, discovered a year ago.

REPUBLIC. There are 150 men employed in this district, and the daily ore production is 200 tons. Results at the Northport S. & R., Last Chance, Knob Hill, and others are reported as good.

SPOKANE. The Loon Lake-Blue Bird Copper Mining Co., capitalized for 1,500,000 shares at 25c. each, of which 500,000 shares are to be held in the treasury, has been incorporated by Andrew Laidlaw, H. H. Schallenger, Lester P. Edge, Joseph McCarthy, and M. L. Moe, all of Spokane, to take over and develop the Blue Bird and Dupont claims, adjoining the Loon Lake Copper Co.'s holdings, 45 miles north of Spokane.

VALEY. There is considerable activity among the recently-discovered magnesite deposits near here.

CANADA

BRITISH COLUMBIA

TRAIL. The electrolytic copper refinery at the smelter is to be enlarged 50%. In the last week of November the smelter received 11,215 tons of ore.

ONTARIO

CORALT. Silver production of the Nipissing for 10 months totals \$2,228,658. Shipments, including custom bullion, were \$3,172,582.

PORCUPINE. In a few weeks the aerial tram being constructed across Pearl lake from the McIntyre company's Extension mine to its mill will be finished, enabling the plant to treat 600 tons daily.

SENBURY. On account of the large increase in nickel mining and proposed new plants, this district is short of electric power, fully 20,000 horse-power.

MEXICO

HIDALGO

PACHUCA. During October the Santa Gertrudis company's profit was only \$1700, from 14,823 tons. Owing to shortage of supplies, it was found impossible to operate the mill at more than half its normal capacity.

SONORA

ALAMOS. Development continues at the Plata-Fina company's property 8 miles east of here. Eight shafts have been sunk from 90 to 115 ft. deep. This, and other work totals 2000 ft., all by windlass. The owner, T. P. Brinegar of Tucson, Arizona, has continued work practically through the years of revolution. Some high-grade silver ore is being opened in a new shaft. Only one other American concern has worked here during the trouble, but two Mexican mine-owners have kept working with arrastras. The other Americans quit 10 months ago, and now none are working within 60 miles of Alamos.

The COLUMBIA Section of the A. I. M. E. met at Spokane on November 25. Stanley A. Easton of the Bunker Hill & Sullivan presiding. The membership has grown from 129 to 158. W. H. Linney was elected chairman, Oscar Lachmund vice-chairman, and L. K. Armstrong secretary-treasurer. C. G. Warfel, assistant professor of mining in the State College at Pullman, read a paper on electric reduction of iron ores of eastern Washington. D. F. Haley of the Interstate Callahan company, and others discussed flotation problems.

The John Fritz medal was awarded in January 1916 to Dr. Elihu Thomson for achievements in electrical inventions, electrical engineering, industrial development, and scientific research. The medal will be presented to him at a meeting to be held in Boston on December 8, 1916.

The Mackay School of Mines, University of Nevada, Reno, will begin its short course for prospectors on January 5, thence to February 2. No charges are made, save a fee of \$5 to cover cost of supplies. During the previous two courses the attendance was 21 and 29 students.

The Utah Section of the A. I. M. E. met at Salt Lake City on December 16. J. M. Callow presented a paper on the "Notes on Flotation, 1916," and Erwin Wille, "Manufacture and Use of Sulphuric Acid."

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

BERNARD MACDONALD is at New York.
H. L. HUSTON has gone to Ely, Nevada.
G. V. MICHELL has gone from London to Tomsk, Siberia.
ROBERT E. CRANSTON has gone to Colorado and New York.
NELSON DICKERMAN returned here from Bolivia on December 4.

H. B. LOWDEN, of the Colorado Iron Works, is in San Francisco.

T. W. MATHER is leaving Guayaquil, Ecuador, for Pacific Grove, California.

A. J. SALE, assayer at Battle Mountain, Nevada, is spending the holidays at Los Angeles.

W. W. MEIN and WALTER KARRI-DAVIES left San Francisco for New-York on December 4.

J. H. MACKENZIE made a visit of inspection to Atolia, in San Bernardino county, last week.

W. E. THORNE, engineer to the Lenskole Gold Mining Co., Lena region, Siberia, is in London.

GEORGE B. HOLDEBER has recently been appointed superintendent to the Northern Pyrites Co., at Northpines, Ontario.

CHARLES E. VAN BARNEVELD has been appointed supervising mining engineer and metallurgist to the U. S. Bureau of Mines.

DRUMMOND MACGAVIN, who is with the Canadian Mining Corporation, at Toronto, is spending the holidays in San Francisco.

M. E. MACDONALD was here early this week, from Los Angeles, accompanied by his brother, JOSEPH MACDONALD, of Guanajuato.

RALPH H. MOORE and F. L. STACK, formerly with the Morococha Mining Co., Morococha, Peru, returned to Mexico early in December.

FREDERICK W. GAY announces that he has opened offices as consulting engineer in power, etc., for mines, at 310 Sansome street, San Francisco.

W. J. ELMENDORF has joined G. M. WELLS and DONALD G. CAMPBELL in a new firm to be known as Campbell, Wells & Elmhendorf, with offices at Seattle.

HENRY F. COLLINS has resigned the executive management of the Huvelva Copper & Sulphur Mines and has accepted the position of consulting engineer to the company.

JAMES MACNAUGHTON, general manager of the Calumet & Hecla, is now living in Boston, where he will spend most of his time, making occasional visits to Houghton.

D. P. THOMAS has resigned as superintendent for the Moose Mountain, Ltd., at Sellwood, Ontario, to accept the management of the Davidson Mines, at South Porcupine.

C. T. GRISWOLD, of the Associated Geological Engineers, has transferred his activities from Wyoming to Oklahoma. M. L. FETTER, managing engineer of the engineering division of this firm, visited New York recently.

H. J. WALLACE, formerly field engineer for the Anaconda company at Great Falls, has been appointed superintendent of construction in place of F. J. BRUE, who has resigned to accept the position of chief engineer for the British America Nickel Co. under E. P. MATTHEWSON.

AUGUSTUS D. COX has resigned as superintendent of the Union Hill mine at Grass Valley to become manager of the mining ventures being financed by the G. S. Johnson Co. ERIC MACBRYEN, who was formerly general manager of the Union Hill mine, will now assume the resident management of this and the other mines that have been acquired by the new corporation known as the Gold Point Consolidated Mines.

THE METAL MARKET

METAL PRICES

San Francisco, December 12.

Antimony, cents per pound	14
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.75-8.75
Platinum, soft and hard metal, per ounce	95-105
Quicksilver, per flask of 75 lb.	\$80
Spelter, cents per pound	13
Tin, cents per pound	45
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, December 12.

Antimony, 50% metal, per unit	\$1.00
Chrome, 40% and over, f.o.b. cars California, per ton	15.00
Magnesite, crude, per ton	6.50-9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO ₃ , per unit	17.50-20.00

New York, December 6.

Antimony ore is unchanged and quiet at about \$1.50 per unit. Molybdenite: A little business has been done at \$1.75 per pound.

Tungsten: Several hundred tons has changed hands in the week at \$18, and an advance is looked for.

EASTERN METAL MARKET

(By wire from New York.)

December 12.—Copper is quieter and irregular; lead is scarce and irregular; spelter is quiet but steadier.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date	Average week ending
Dec. 6	34.50
" 7	34.75
" 8	35.00
" 9	35.00
" 10 Sunday	35.00
" 11	35.00
" 12	35.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	33.60	34.50	July	32.36	29.09
Feb.	34.46	34.28	Aug.	32.34	27.93
Mar.	34.11	34.80	Sept.	32.02	27.69
Apr.	34.19	36.64	Oct.	31.16	28.28
May	33.97	38.21	Nov.	31.17	31.95
June	33.60	39.75	Dec.	31.75	29.67

Copper production of 26 large mines in North and South America totals 1,700,000 lb. for 10 months, a great increase over this period in 1915.

Anaconda produced 25,500,000 lb. in November, a decrease of 6,000,000 lb. due to cold weather. Inspiration yielded 10,600,000 lb., Old Dominion, 3,650,000 lb.; Miami, 4,968,500 lb.; East Butte, 1,648,040 lb.; Chile Copper, 4,098,000 lb.; Cerro de Pasco, 5,700,000 lb.; Arizona Copper, 4,380,000 pounds.

Dividends declared are: Champion, \$6.40; Shattuck-Arizona, \$1.25; United Verde, \$1.50 (\$4,050,000 for 1916, of which W. A. Clark receives \$4,000,000); Old Dominion, \$3.50; Utah Copper, \$3.50; Nevada Con., \$1.50; Ray Con., \$1; Chino, \$2.50 per share.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date	Average week ending
Dec. 6	75.62
" 7	75.62
" 8	75.25
" 9	75.25
" 10 Sunday	75.25
" 11	75.50
" 12	76.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	July	54.90	47.52
Feb.	57.53	48.45	Aug.	54.35	47.11
Mar.	58.01	50.61	Sept.	53.75	48.77
Apr.	58.52	50.25	Oct.	51.72	48.77
May	58.21	49.87	Nov.	49.12	51.88
June	56.13	49.03	Dec.	49.27	55.34

The silver market is strong. Slight recessions in price are the natural reactions of a healthy market. The present strength is due to firmness of China exchanges, apart from the European and Indian currency demand. There is a shortage of sycee

(bars) in the East. As long as Chinese export business keeps active there is expected to be a firmness of exchange.

On December 8 silver valued at \$1,056,000 (say 1,400,000 oz.) was shipped from San Francisco to Shanghai.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date	Average week ending
Dec. 6	7.50
" 7	7.62
" 8	7.75
" 9	7.80
" 10 Sunday	7.85
" 11	7.85
" 12	7.90

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	July	3.80	5.59
Feb.	4.02	3.83	Aug.	3.86	4.57
Mar.	3.94	4.04	Sept.	3.82	4.62
Apr.	3.86	4.21	Oct.	3.60	4.62
May	3.90	4.24	Nov.	3.68	5.15
June	3.90	5.75	Dec.	3.80	5.84

Dividends declared by three Park City, Utah, companies, are as follows: Judge M. & S. Co., \$120,000; Silver King Coalition, \$187,500; and Silver King Consolidated, \$95,250.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date	Average week ending
Dec. 6	12.75
" 7	12.62
" 8	12.12
" 9	12.00
" 10 Sunday	12.00
" 11	12.00
" 12	12.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.30	July	4.75	20.54
Feb.	5.22	9.05	Aug.	4.75	14.17
Mar.	5.32	8.40	Sept.	5.18	14.14
Apr.	4.98	9.78	Oct.	4.75	14.65
May	4.91	17.03	Nov.	5.01	17.20
June	4.84	22.20	Dec.	5.40	16.75

Butte & Superior has declared \$6.25 per share. The Interstate-Callahan will pay \$1.50 per share on the 30th, equal to \$697,485. This makes \$2,789,940 for 1916, and \$5,317,385 since April 1, 1915.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending
Nov. 14	80.00
Nov. 21	80.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.30	July	37.50	95.00
Feb.	39.00	60.00	Aug.	38.00	93.75
Mar.	39.00	78.00	Sept.	37.25	91.00
Apr.	38.90	75.50	Oct.	37.00	92.90
May	39.00	75.00	Nov.	35.00	101.50
June	38.60	90.00	Dec.	35.10	123.00

TIN

Prices in New York, in cents per pound.

	Monthly averages					
	1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38
Feb.	39.76	37.23	42.50	Aug.	30.20	34.37
Mar.	38.10	48.74	54.98	Sept.	33.10	32.12
Apr.	36.10	48.25	50.49	Oct.	30.40	33.00
May	33.29	39.28	49.10	Nov.	33.51	39.50
June	30.73	40.26	42.97	Dec.	33.60	38.71

Tin is quiet at 43 cents.

ANTIMONY

Importers are maintaining their quotations firmly, and report a fair business, but dealers say that business is dull. The quotation for Asiatic grades is 14 to 15.00c, duty paid, New York.

ALUMINUM

The market is firm, but unchanged, at 63 to 65c. for No. 1 virgin metal, 98 to 99% pure.

Eastern Metal Market

New York, December 6.

The quieter tendency in copper has continued, largely because near-by metal is scarce, even first quarter being difficult to obtain, but the strength of prices is unimpaired. It is believed, however, that they have reached their apex.

Statements pertaining to possible over-production of zinc have disturbed the trade. Second-hands have been selling this week and have caused prices to soften.

Lead is stronger and quotations are more uniform following an announcement by the A. S. & R. Co., December 5, fixing its New York price at 7.50 cents.

Tin has been dull and lower, the November statistics having been interpreted unfavorably.

Antimony and aluminum are unchanged.

In pig iron there is a quieter market, but quotations are firm around \$29 to \$30, furnace, for eastern Pennsylvania and Buffalo iron, also at central-western furnaces.

The November production of pig iron dropped below the enormous production of October. The total was 3,311,811 tons, or 110,394 tons per day, against 3,508,849 tons in October, or 113,189 tons daily. Even at the lessened production no other month than October equalled the November output. The production always drops in November for seasonable reasons, while this year the furnaces had to cope with shortages in their coke deliveries, and the virtual breaking-down of furnaces that had been hard pressed for months. Several were blown-out for re-lining. The export demand for pig iron is extending more and more to foundry grades, although the demand for steel-making iron continues heavy.

COPPER

November was a great month in the copper market, the volume of sales being estimated at around 600,000,000 lb. Next to September, the month just closed was the largest in the history of the copper industry. In the past week buying has been much quieter, although there still is unsatisfied demand. The absorption of the metal has been so great that first-quarter delivery is about as difficult to arrange as it is to procure spot. The scarcity of near-by copper has served to restrict sales, while another influence making for a quieter market is that the larger consumers have covered their needs. Although there is less doing, prices are as strong as ever, even a trifle stronger. Both electrolytic and Lake for delivery to the end of the year is held at 31.50c., while first quarter is about 31 to 31.50c., second at 32.50 to 33c., third 30.50 to 31c., and fourth 30 to 30.50c. Strictly spot metal commands 35c., and small lots have sold over this figure. It is the general opinion that prices have reached the top notch, and considerable satisfaction is felt thereat, for the reason that further advances would be dangerous, according to the trade. A saving clause in the situation is that the bulk of the buying of late has been done to cover contracts actually in the hands of consumers, and only the abrogation of these contracts would make the buyers decline to take the copper purchased. Of course, contracts are not supposed to be broken, but most of the war contracts have cancellation clauses. The London market for spot electrolytic yesterday was strong at £170, or £1 higher than a week ago. November exports totaled 21,433 tons. In 11 months of this year exports totaled 229,659 tons, against 233,918 tons in the same period of 1915, an increase of 65,741 tons. It is regarded as certain that the large French inquiry which came before the trade a few weeks ago will soon develop into business. In the past few days dealers have handled the bulk of the sales.

ZINC

On Monday of this week (December 1) the upward trend of

prices was halted by a decision on the part of second-hands that it was time for them to take profits. The New York price has reached 13.25c., but under the pressure of offerings it dropped, until yesterday, the 5th, to 12.75c., New York, and 12.50c., St. Louis, for prompt, were done. First quarter was about 1c. per lb. less. The selling at concessions was started entirely by dealers, but it was not long before some of the large producers were meeting the lower prices. Certain large producers, however, are not at all dismayed by the break in the market. They point out that there has been a steady rise, lasting through all November, and that perhaps a little check just now may be healthy, particularly in view of the fact that it probably will bring down the price of ore. They are of the opinion—in fact, one or two little bets have been made on the subject—that the price will touch 14c. early in January. They hold this view despite the expressed opinion of some experts with regard to over-production, views which were in part responsible for the decision of dealers to sell. It is undoubtedly true, as C. E. Siebenthal of the U. S. Geological Survey pointed out early in the year, that production has increased enormously, yet the consumption is great also. Exports in November totaled 16,098 tons. Production will be cut down this winter, as it is every cold season. Snows interfere with mining and the cold hampers the gas supply and furnace operation. From Joplin comes the news this week that two out of three large steam turbines used by an electric-power company supplying the district had broken down under the strain of overload, and would be out of commission for two or three weeks, the one turbine operating being used to pump-out the mines. This news quickly had the effect of checking a decline in the price of ore. The London spot market was 10s. lower yesterday at £58 10s., as compared with a week previous. Fundamentally the position of the metal is strong, despite its ups and downs because of the influences referred to. Sheet zinc is unchanged at 21c., f.o.b. smelter, carload lots, 8% off for cash.

LEAD

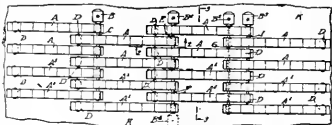
The A. S. & R. Co. finally took action yesterday; and in the course of the day advanced its price twice. It first announced that its New York quotation had been advanced from 7 to 7.25c., then, that it had fixed the New York price at 7.50c. The independents already had been quoting over 7.50c., New York, for prompt delivery, in fact some were asking 7.75c., New York. December lead has been at a premium because of its scarcity, little or none being available at any price. Following the action of the big producer the market steadied at 7.50 to 7.62½c., New York, independents asking 7.40c., at St. Louis. Prior to the announcement of the leading producer it was difficult accurately to gauge the market, inasmuch as prices covered a wide range. The London spot quotations continue unchanged at £30 10s. Exports in November totaled 1436 tons. Lower prices for lead are not looked for in the near future.

TIN

Since the last report the market has been dull. On December 4 some likely-looking inquiry came out, but it was followed immediately by the announcement of the November statistics. These did not look good to consumers and they withdrew from the market. The most adverse feature of the figures was the showing that the total visible supply had increased 3771 tons in November. The total visible supply October 31 stood at 17,415, whereas a month later it amounted to 21,186 tons. Deliveries into consumption in November were fair, amounting to 3165 tons, of which 365 tons arrived at Pacific ports. Total deliveries in 11 months of the year totaled 51,553 tons against 41,962 tons in the same period of 1915, an increase of 6591 tons. The quantity now afloat is 6168 tons.

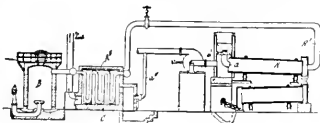
RECENT PATENTS

1,199,818. CONVEYER SYSTEM. Staunton B. Peck, Philadelphia, Pa., assignor to Link-Belt Company, Chicago, Ill., a Corporation of Illinois. Filed Jan. 16, 1915. Serial No. 2521.



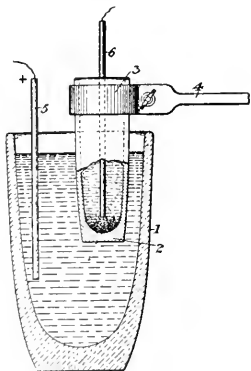
1. A conveyer comprising successive groups of over-lapping parallel conveyer sections and means for independently driving each group.

1,196,049. PROCESS FOR REMOVING IRON FROM TIN ORES. Günzel von Rauschenplat, Steglitz, Germany, assignor to Barilla Limited, London, England, a Corporation of Great Britain. Filed Jan. 28, 1914. Serial No. 815,029.



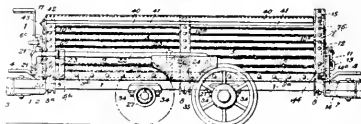
1. The herein described process for removing iron from iron-bearing tin ores, which consists in subjecting the ore to a reducing treatment at a temperature at which the tin will remain in a form insoluble in acids, while the iron contents will be reduced to a form readily soluble in acids, and then subjecting the resulting product to treatment with acid.

1,196,699. ART OF PRODUCING TUNGSTEN POWDER. Frederick G. Keyes and Robert B. Brownlee, Hoboken, N. J., assignors to Cooper Hewitt Electric Company, Hoboken, N. J., a Corporation of New Jersey. Filed Feb. 17, 1915. Serial No. 8769.



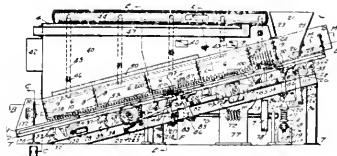
The combination with a crucible, of fused sodium tungstate within the same, a porous cup dipping into the fused material and permitting the said material to enter the said cup to substantially the level of the material in the crucible, an anode extending into the crucible and the fused material therein and a cathode dipping into the material within the porous cup.

1,199,794. MINE-CAR. Warren V. Johnson, Bloomsburg, Pa., assignor to American Car and Foundry Company, St. Louis, Mo., a Corporation of New Jersey. Filed Aug. 4, 1916. Serial No. 113,127.



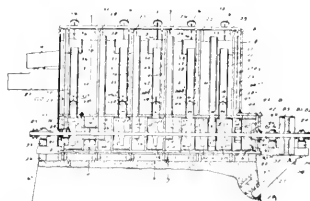
1. In combination in a mine car, a wood floor portion, metallic body bands extending beneath said floor near its ends and intermediate its ends and secured directly to said floor, corrugated metal side body sheets secured directly to said body bands, flanged members connecting the side body sheets with said floor, longitudinally spaced journal boxes connected to each of said flanged members by bolts extending through said journal boxes, the floor and said flanged members, a fixed end wall and a hinged gate.

1,199,962. SINTERING-MACHINE. Sophus P. C. Borson, Salida, Colo. Filed Aug. 23, 1915. Serial No. 46,959.



1. In a machine for sintering and roasting ore, the combination with a movably supported ore carrier comprising an impervious bed member with projecting joint members, of a fixed ore retainer comprising two oppositely disposed perforated side walls provided with depending flanges adapted to combine with the said joint members to form sliding joints, means attached to the said ore retainer for forcing a blast of air through the material under treatment, means for supporting the said ore carrier and ore retainer, and operating means attached to the said ore carrier adapted to produce comparatively slow forward motion and a comparatively rapid return motion thereof, substantially as shown and described.

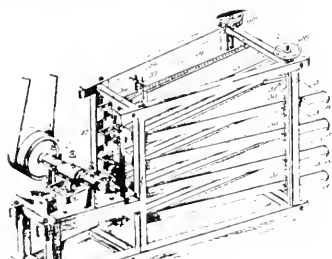
1,197,843. APPARATUS FOR SEPARATING OILED CONCENTRATES FROM THE GANGUE OF ORES. Ralph T. Mishler, Pomona, Cal. Filed Sept. 13, 1915. Serial No. 50,457.



1. In an apparatus for separating concentrate from the gangue of ores, the combination with a longitudinal pulp receiving case, provided with transverse partitions separating the interior of said case into pulp receiving chambers, and

with superposed pulp separating receptacle supported by said case and provided with passages from the respective pulp separating chambers, of pulp conducting stand pipes for conducting the pulp from one pulp receiving chamber to a superposed pulp separating receptacle, and having their lower ends connected with the inlet passages from the pulp receiving chambers, said chambers being provided with separate outlet passages leading from said pulp separating receptacles to said pulp receiving chambers, a longitudinal shaft extending through said case and said chambers, and means on said shaft within said chambers for forcibly discharging the pulp from said chambers through said stand pipes above the level of the pulp in the pulp separating receptacles.

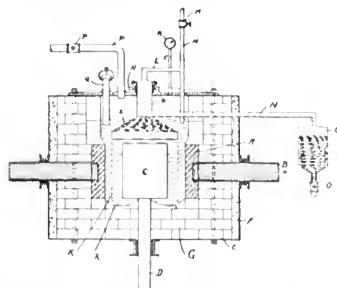
1,201,151. ORE-CONCENTRATOR. George T. Cooley, Joplin, Mo., assignor to one-half to James Athel Brent, San Francisco, Cal. Filed Nov. 10, 1914. Serial No. 871,307.



1. In an ore concentrator, the combination with a frame, of a bolster, means for suspending the latter from the frame, a plurality of tables pivotally and yieldably connected with the bolster at one end, means connected with the tables for adjusting their inclination, and a head motion attached to the bolster.

2. In an ore concentrator, the combination with a frame, of a plurality of three-point suspension tables suspended in the frame, one of which suspensions is a horizontal pivot, and means at the sides for adjusting the inclination of the tables simultaneously upon said pivots.

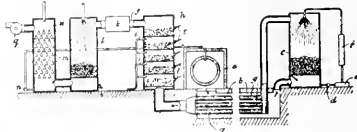
1,197,137. METHOD OF REDUCING METALS. Robert J. McNil, Perth Amboy, N. J., assignor to The Roessler & Hasslacher Chemical Co., New York, N. Y., a Corporation of New York. Filed Jan. 2, 1913. Serial No. 739,710.



1. A method of reducing metallic compounds to their metals by electrolysis consisting in raising the boiling point of said metals by pressure on the molten electrolyte while maintaining the temperature of the electrolyte below its boiling point at atmospheric pressure.

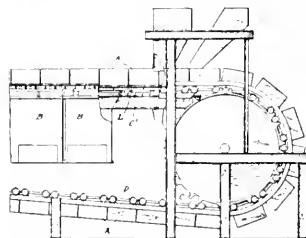
2. A method of reducing metallic compounds to their metals by electrolysis consisting in raising the boiling point of said metals by pressure of a compressed gas on the molten electrolyte while maintaining the temperature of the electrolyte below its boiling point at atmospheric pressure.

1,197,331. PROCESS FOR THE MANUFACTURE OF SULFURIC ACID. Lucien Paul Basset, Paris, France. Filed July 5, 1916. Serial No. 107,597.



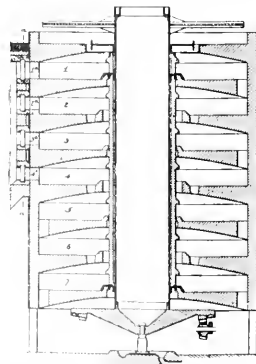
1. A process of producing sulfuric acid which comprises passing gases containing sulfur dioxide and oxygen in contact with a catalytic substance capable of partially oxidizing the sulfur dioxide, removing the so oxidized portion, and thereafter absorbing the unconverted residue of sulfur dioxide in a calcareous material suitable for use in making cement.

1,197,199. APPARATUS FOR ROASTING AND SINTERING ORES. James Gayley, New York, N. Y., assignor to American Ore Reclamation Company, New York, N. Y., a Corporation of New York. Filed May 6, 1916. Serial No. 95,775.



1. In a continuous sintering machine of the kind described, the combination with a wind box, a series of grate bearing pallets, and supports therefor which permit the pallets to be moved over the continuous top of the wind box, of series of sectional seal bars or curtains intermediate to the pallets and wind box adapted by their adjustment to automatically close the joints between said pallets and the wind box and thus prevent impairment of the air-tight union between the two.

1,198,882. TREATING LEAD MATTE. Utley Wedge, Ardmore, Pa. Filed Jan. 29, 1913. Serial No. 744,894.



The mode herein described of roasting lead matte in a furnace of the superposed hearth type, said mode consisting in carrying said lead matte forwardly through the furnace, retarding sulfur elimination by abstracting heat from the furnace until the sulfur has been so far reduced as to permit of the free application of the heat necessary to effect the desired desulfurization, and then applying such higher heat.

Company Reports

Consolidated Gold Fields of South Africa

An abstract of the report of this great company for the year ended June 30, 1916, should interest American mining men on account of the company's interests in this country. The principal holdings throughout the world are in 34 companies—gold, tin, potash, power, etc.

The realized profit—mainly from dividends received on investments, after deducting debenture interest, etc., was £440,141. After paying dividends and taxes the balance was £283,917; and after allowing for depreciation, and adding the previous balance, there remains £231,740 (\$1,120,000). From this was paid 7½% on ordinary shares, amounting to £150,000.

Some details of the properties controlled by the Consolidated Gold Fields company are as follows:

MINES IN THE TRANSVAAL

Name	Reserves, tons	Ore treated, tons	Yield per ton	Cost per ton
Simmer & Jack.....	1,935,000	788,700	\$5.26	\$3.50
Robinson Deep.....	1,849,000	646,900	6.84	4.60
Knights Deep.....	2,614,000	1,307,300	3.64	2.90
Simmer Deep.....	1,492,000	762,800	4.12	3.85
Jupiter.....	1,178,000	234,000	5.04	4.62
Sub Nigel.....	214,000	93,260	9.56	7.52
Crown Mines.....	9,938,000	2,332,000	6.18	4.32
Government (Mollderfontein).....	4,368,000	627,200	6.42	4.86

In the last two the company has a minor interest. The total working profit from the other companies was \$424,000, a small reduction compared with the previous year, although more ore was treated. Owing to the War the companies lost a large number of efficient employees, and had to pay increased charges on supplies, bullion, and taxes.

TRANSCONTINENTAL CONSOLIDATED OIL CO. The area held in the Panuco and Huasteca fields of eastern Mexico totals over 10,000 acres. Six wells are yielding 10,000 bbl. daily. Equipment is equal to three times this quantity. The properties produced 736,881 bbl. Profits earned were sufficient to pay dividends on preferred stock. The International Petroleum Co. produced 582,124 bbl., which was handled by the Transcontinental company.

GRANVILLE MINING CO. The Canadian Klondyke Mining Co. recovered 72,464 oz. of gold in the last season, and 34,112 oz. to September of the current season. As there was a shortage of repair parts the dredges did not operate at highest capacity. The North West Corporation removed 779,000 cu. yd. of overburden.

SIERRA PACIFIC ELECTRIC CO. Net earnings of this concern in 1915 were \$279,710, and in seven months ended July 31, 1916, \$173,376, a slight improvement. Subsidiaries serve 25% of the total population of Nevada.

YUBA CONSOLIDATED GOLD FIELDS. During the year ended February 29, 1916, the dredges recovered 2,133,529, equal to 12.02c. per yard. Expenses totaled 4.27c. per yard. In the five months to July 31, 1916, the average grade was 12.87c., with 3.7c. cost. The present rate of profit is \$1,800,000 per annum.

NATOMAS COMPANY OF CALIFORNIA. The net profit in 1915 was \$1,570,799. For the seven months ended July 31 the net result was \$588,789, a low return due to less dredging operations.

LA GRANGE MINING CO. About 2,000,000 cu. yd. was sluiced last season, costing 4c. per yard. The total clean-up was \$39,763, and expenses \$80,000, making a loss of about \$40,000.

If a tunnel is driven 1100 ft., so as to shorten the sluice by a half, thus decreasing its maintenance, and increasing the grade, about 4,000,000 cu. yd. could be handled at 1½ to 2c. per yard. It is not possible to sample the gravel ahead of hydraulicking.

MISSISSIPPI RIVER POWER CO. This company's great power-plant is at Keokuk on the Mississippi, half-way between Chicago and Kansas City, and 140 miles north of St. Louis. The possibilities for sale of power in this region are enormous. In 1915 gross earnings were \$1,651,269, and net \$1,326,868. For seven months in 1916 the profit was \$792,227.

AMERICAN TRONA CORPORATION. Considerable annoying litigation was settled in April, when the Supreme Court of California decided in favor of the company involving holdings of shares in the California Trona Co., which owns claims on Searles lake. Other suits by claim-jumpers were awarded the corporation. The last question in dispute is the settlement with the United States government on the validity of the California Trona Co.'s claims at Searles lake. After many tests a process was evolved for treating the brine. Concentrated salts are being produced at Trona at the rate of 50 tons daily, from 400,000 gal. of brine. This quantity of potash is to be increased by adding to the plant. A refinery is well on toward completion at San Pedro, near Los Angeles. The Trona salts have a high market value, and a contract has been closed for 3500 tons to be shipped by the end of 1916. The Trona railroad of 30 miles, connecting Trona with the Southern Pacific at Searles, had a revenue of \$53,000 and \$23,000 profit. Mining in the vicinity is responsible for these good results.

Prices of Chemicals and Old Metals

Acetic acid, cents per pound.....	50—55
Arsenic, white, cents per pound.....	6—6½
Barytes, prime white foreign, per ton.....	\$35—40
Borax crystals, cents per pound.....	7½—7½
Caustic soda, 76%, cents per pound.....	3½—4
Creosote, cents per pound.....	2½—3
Cresol, per gallon.....	\$1.36
China clay, imported, per ton.....	\$18—30
Feldspar, per ton.....	\$8—10
Fuller's earth, foreign, powdered, per ton.....	\$25
Hydrochloric acid, commercial, cents per pound....	1½—1½
Lead acetate, white crystals, cents per pound.....	13½—14
Litharge, cents per pound.....	9½—9½
Nitric acid, cents per pound.....	4½—6½
Potassium cyanide, cents per pound.....	70—72
Phosphate rock, Florida, 68%, per ton.....	\$2.75—3.00
Potassium iodide, cents per pound.....	4
Pyrite, furnace size, imported, cents per unit.....	15½
Silver nitrate, cents per ounce.....	42½
Soda ash, cents per pound.....	3
Sodium nitrate, cents per pound.....	3
Sulphur, crude, per ton.....	\$35
Sulphuric acid, 66° B., per ton.....	\$20—21
Talc, American white, per ton.....	\$9—12
Tar oil, cents per gallon.....	35—40
Aluminum, old cast, cents per pound.....	32—32½
Copper, light, crucible, wire, or heavy, cents.....	21½—25½
Brass, cents per pound.....	14½—17
Lead, cents per pound.....	6½—6½
Tin, block, cents per pound.....	40
Zinc, cents per pound.....	9—9½
Electrotype, cents per pound.....	6½
Old rails, per ton.....	\$25
Old car-wheels, per ton.....	\$24
Heavy cast-iron scrap, per ton.....	\$17
Machine-shop turnings, per ton.....	\$10

Recent Publications

SAFETY AND EFFICIENCY IN MINES. By Edwin Higgins. Bulletin No. 3 of Industrial Accident Commission of California. P. 14.

NOTES ON THE INVENTION, DEVELOPMENT, AND INTRODUCTION OF THE FLOTATION PROCESS. By A. Stanley Elmore. P. 20. Reprint from the MINING AND SCIENTIFIC PRESS, and issued by the Ore Concentration Co. of London.

A SERIES OF TREATISES ON THE RARE METALS. By Herman Fleck. P. 73.

These lectures were delivered at meetings of the Colorado Scientific Society, Denver, in 1915 and 1916. The metals discussed were tungsten, molybdenum, vanadium, and uranium. We have already abstracted from the notes. At this time the publication is worth securing.

U. S. Bureau of Mines, Washington, D. C., 1916:
ORE-SAMPLING CONDITIONS IN THE WEST. By T. R. Woodbridge. Technical Paper 86. P. 96. Ill. index.

Important points from this useful investigation were abstracted for the Press of November 11.

MELTING ALUMINUM CHIPS. By H. W. Gillett and G. M. James. Bulletin 108; Mineral Technology 14. P. 88. Index.

U. S. Geological Survey, Washington, D. C., 1916:
MEASUREMENT OF SILT-LADEN STREAMS. By R. C. Pierce. Water-Supply Paper 400-C. P. 13.

GEOLOGY OF THE HOUND CREEK DISTRICT OF THE GREAT FALLS COAL FIELD, CASCADE COUNTY, MONTANA. By V. H. Barnett. Bulletin 641-H. P. 17. Map.

THE GOLD LOG MINE, TALLADEGA COUNTY, ALABAMA. By Edson S. Bastin. Bulletin 640-I. P. 3.

THE YUKON-KOYUKUK REGION, ALASKA. By H. M. Eakin. Bulletin 631. P. 88. Ill., maps, index.

Notes on a district that has no deposits of value, as far as discovered.

Book Review

LUBRICATING ENGINEERS' HANDBOOK. By J. R. Battle. P. 323. Ill., plans, index. J. B. Lippincott Co. Philadelphia, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$4.

We have perused this work on a very important subject with much interest, and consider it worth a place in every oil and mechanical engineer's library. To the mining man, the statement that "the most essential and yet the most neglected detail necessary to obtain the best results from pneumatic tools (drills, etc.) is proper and efficient lubrication," will be found appropos; also the remarks on lubrication of pumps and cars. In these times of high-speed engines, whether steam or oil-driven, lubrication is of paramount importance. Engines are not the only machinery to be considered, there being a thousand and one machines that require oil or grease at some part. Wherever two surfaces work against one another, friction and heat results, requiring a lubricant to reduce this as low as possible. The author terms this a "friction tax." Picking out several chapters of the book we find tersely given and practically illustrated, the theory of lubrication, petroleum and other lubricants and their manufacture, vegetal oils (under the caption "vegetable oils"), tests of oils and grease, miscellaneous notes on oil, steam engines and turbines, bearings, lubricating apparatus, air-compressors, automobiles, Diesel engines, internal-combustion engines, locomotives, and the cost of lubrication. The index of 20 pages is well arranged.

Industrial Notes

Information supplied by the manufacturers.

Catalogue No. 14 of the NATIONAL TANK & PIPE CO., Portland, Oregon, consists of 48 pages of well-illustrated data, including four full-page colored views of pipe-lines installed by the firm. Brief discussions are given on the strength, life, capacity, and uses of wood-pipe. Ten reasons are stated for using this product. Fittings for pipe are shown and described. As far back as 1799, New York used wood-pipe for its water-supply. Some useful tables are appended.

The INGERSOLL-RAND CO. of New York has issued form 8311 of 16 pages on 'Little David' pneumatic riveting-hammers, inside trigger pattern. These hammers are offered in six sizes, the dimensions and specifications of which are listed in the catalogue. An important feature of this tool is the rivet-set retainer designed to meet the regulations and requirements of the safety appliance laws enacted in the various States. Form 3130 of 24 pages is on class ER-1 power-driven single-stage straight-line air-compressors. Machines are built in various sizes from 6 to 12-in. stroke, with a piston displacement capacity of 52 to 955 cu. ft. per minute and are equipped with the Ingersoll-Rogier type of air-valve.

Several types of tractors are in use for hauling ore, supplies, and machinery in mining districts. A machine has been devised by R. Hamilton of Geyserville, California, and severe tests are said to have proved its reliability. It is 3½ ft. wide and 7 ft. long, and weighs 1750 lb. The motor, gearing, and frame are of good design. Distillate is used for fuel. The special advantage, as may be seen from the picture, is the traction arrangement. The periphery of each wheel is fitted with 16 two-pronged forks, 7 in. long and 9 in. wide, which dig into the ground, giving great tractive effect, especially on rough or muddy roads. The clearance of the frame above ground is 10 in. under normal working conditions. Like several other tractors this one was developed on a farm.

The suit brought by the KOERING CYANIDING PROCESS CO. against the Wasatch Utah Mining Co., of Sandy, Utah, has been decided in favor of the Koering company. The evidence presented showed that the Koering company installed a unit for the treatment of what was represented as being a large ore-body, but which subsequently proved to be not the case, as after a three weeks' run the ore supply was exhausted. The Wasatch company will return the equipment and also pay damages to the Koering company for misrepresentation of the facts in the case. The Koering company has issued a pamphlet entitled, 'The highest development of the copper-leaching art,' in which is described the use of its plant for sulphuric acid instead of cyanide. Detailed costs are given.

Announcement has been made by the WESTINGHOUSE ELECTRIC & MFG. CO. of an extension of its present bonus system to include salaried and office employees on hourly rates, by which they will receive a bonus of 8% of their salary each month, providing their total excusable time absent and late during the month does not exceed 6 hours incurred on not over three occasions. An additional 4% will be given each month to the employee who has not lost any time from work during the month through absence or tardiness, thus enabling those affected to obtain an increase in earnings of 12% for a 100% attendance. Several thousand employees in the Pittsburgh district are benefited by the granting of the bonus. The company has issued a circular discussing electric-furnace equipment. One great improvement is the automatic regulation of current, the Thury regulator being extensively used.

EDITORIAL

T. A. RICKARD, Editor

SUBSCRIPTION of \$5,000,000 to the purchase of United Kingdom 5% notes by the copper companies under Jackling management is announced at New York. This is stated to be "a matter of reciprocity," seeing that the Allies are buying so much of the copper produced by this group of mines.

AMONG the destructive consequences of the War we should take note of the loss of metal as cargo on ships that are sunk as well as the metal in piping and fittings that are sent to the bottom, where none of it can be salvaged. On the *Chemung*, sunk on November 27, was a large tonnage of copper, zinc, and steel.

IT IS estimated that the increase in the sum of wages distributed in the organized industries of the United States since the beginning of 1916 is about a billion dollars. Notwithstanding this colossal increase in wages it is doubtful whether the average worker has gained any advantage, for the increase of income is less than the rise in the cost of living.

SELECTIVE flotation, based on the Owen idea, has been developed at the Broken Hill South mill to the point of obtaining a 62.6% lead concentrate containing 45.6 ounces of silver and only 9.6% of zinc. The silver minerals escape water-concentration owing to their fissibility, causing them to break into minute flakey particles, which are well adapted to being buoyed by bubbles.

OUR friends at Oatman make a mistake in comparing their rich and prosperous little district with the Rand, or with the Mother Lode, as we note is done by Mr. C. F. Spilman, who has taken charge of the publicity department of the Oatman Bureau of Mines. The Rand goldfield is mined continuously for a length of 40 miles and produces over \$180,000,000 per annum. The Mother Lode is worked along a length of 100 miles and produces \$6,500,000 per annum. Oatman is good enough; no benefit can come from comparisons that are essentially exaggerations.

THE Western Federation of Miners has changed its name to the International Union of Mine, Mill, and Smelter Workers. Some change was urgently needed, but the substitution of a new name will not suffice. We would like to see the organization out of the hands of men that have used labor-unionism to terrorize industry and to promote anarchy. The "international" suggestion is not good. All of us—employers and employees—

are subject to the laws of our State and Nation, and to them we owe respect. Labor troubles cannot be settled on an international basis. If the idea is to incite international strikes, it is wrong.

PEACE has greater terrors than War for Wall Street, as was evident last week. The near panic that came between the German proposal and the Russian rejection of negotiations is an indicator of what may happen when a genuine approach is made to cessation of fighting. The episode proves that New York is far from being the financial centre of the world—it is the biggest gambling centre, that is evident.

LARGE bonuses are being paid by mining and manufacturing companies to their employees at Christmas or New Year. This shows the right spirit, for abnormal profits are being made; but it is to be hoped—against experience—that the abnormality of the times and the exceptional character of the bonuses will be appreciated, so that the reversion to ordinary wages will not be accompanied by unreasoned bitterness between employer and employee.

QUEER shifts may be made to prolong the life of a mine. We remember one that appeared, after careful examination, to have enough ore to last for two years, yet operations continued for five years. Long afterward the engineer that had made the examination met the superintendent and asked him how he managed to do it. Did the mine pay during the extra three years? "No," he replied, "it did not, but the boarding-house did—and I ran the boarding-house."

AMONG the sensible and kind actions to be associated with this Christmas we note the club-house for railroad men to be built by Mr. J. Parke Channing at a little junction point, in the iron region of northern Michigan, that is named after the donor. Our contemporary the *Mining Gazette* mentions the matter in a friendly way and expresses the hope that other men similarly successful in the Copper Country will follow the example and show some practical remembrance of the locality where they started on the road to fortune.

GOOD WORK in flotation is being done at the Atlas mine, near Sneffels, Colorado, where a silver-lead ore assaying 21% lead and 8½ oz. silver per ton is being treated at a recovery of 90% of the lead and 93% of the silver. By re-treatment of the flotation product, on tables, the silica content is reduced from 15-20% to

about 10%. The recovery is 25% better than it was formerly when using ordinary wet concentration. The concentrate assays 16% lead, 35 oz. silver, and 0.22 oz. gold. The cost of milling, treating only 100 tons daily, and concentrating 10:1, is 94 cents, to which 12 cents per ton must be added for royalty.

ON another page we record the conclusion of the Shockley episode. It will be seen that the directors of the American Institute realize that a mistake was made and regret the apparently mandatory tone of the message sent by them to San Francisco. It was the friendly letter of the President, however, that had most to do with the prompt acceptance of the apology and the expression of goodwill that was voted by our local section. The incident, and the discussion of it, has been salutary. Having regard to sundry criticisms—always welcome—from some of our friends on the Eastern seaboard, we take the opportunity of stating that it is part of the proper function of a professional journal to protest against any trespass on the rights of a member of the profession and to defend him when occasion arises.

NECESSITY is proverbially the mother of invention. This is illustrated by two of the photographs accompanying Mr. Sumner S. Smith's article on the Caehe Creek dredge. One photograph shows how a small single-cylinder gasoline-engine, mounted on a truck, is geared to a sprocket that, in turn, is geared to the wheels of the truck, which hauls the ore, and thereby displaces a much less effective mule. This locomotive brings ore two miles from the Cymru mine to the dock on Moira Sound, on the east coast of Prince of Wales island. The other illustration is not as clear because the engine is covered by canvas. A small gasoline-engine is belted to a bull-wheel operating a piston that drives a cross-cut saw held in place by the two guides, which can be seen clearly. The log is held in place by a couple of 'dogs.' The pond fills with wood that has been sawed; the machine is then pulled ashore, and an abundant supply of fuel is left on the beach when the tide recedes.

OWING to the lavish production of copper ore at this time, most of the larger smelters are unable to accept small lots of custom ore for treatment. This works a hardship on the owners of little mines that can supply a limited tonnage of relatively high-grade ore. There are many small mines that can produce a considerable tonnage of 5 to 10% ore, such as would yield a satisfactory profit at the present price of the metal, if the ore could be smelted. The big smelters are overloaded with ore sent to them under contract from regular customers, including mines controlled by the smelting company itself, so that they find it inexpedient to accept ore from the small shipper, except on terms so exacting as to pile insult on the injury that the minor producer already feels, owing to being denied an opportunity to share in the benefit of an abnormally high market for copper. We appreciate the bitterness of his position and advise

him to investigate wet methods of extraction. Undoubtedly the smelter congestion should stimulate experimentation in the hydro-metallurgy of copper.

RUSSIAN gold production has varied during the past 12 years between \$22,000,000 and \$35,000,000 per annum, the last four years showing a gain of about \$2,000,000 successively. The latest available figures are \$26,750,000 for 1914. The correctness of these Russian gold statistics are open to doubt, as the exact amount of gold recovered is not really known, partly because the department dealing with the industry is not as well organized as our own or those of other countries, and partly because of the legalized theft prevailing in the gold mines, causing a good deal of the product to be smuggled across the border into China, which for many years was credited with a preposterous production of gold. However, the somewhat stationary condition of gold mining in Russia and Siberia, it is reported, has at last attracted the serious attention of the Government, which is showing an inclination to act upon the resolutions passed at the various conferences that have been held in the empire, including the gold and platinum producers, calling for measures of support and stimulation. The area allotted for exploitation of gold has decreased in recent years, also the quantity of gravel treated, for, at present, most of the Russian yield is from placers. Gold is known to exist, in quantity inviting mining, over a million square versts, of which only 5000 versts is being exploited. The Government is being urged to throw open more of the Crown lands for mining exploration, to send geological expeditions into the field, and to facilitate colonization of the known gold-bearing areas. Lack of the means of transport hinders new work even in regions that are open to exploitation. Good roads are wanted, as also the extension of the postal and telegraphic services, which are the nerves of industry. It is said that many old dumps of half-washed gravel, left by operators using crude methods, are available for profitable re-treatment. Lode mining for gold is yet in its beginning, and in this respect affords a curious contrast with the recent growth of activity in copper, lead, and zinc mining, particularly in the Ural, Akmolinsk, and Altai regions. Of course, the War and its financial exigencies should cause the Russian government to do all it can to stimulate the winning of gold from the ground. We believe that it will, and in doing so that it may find it advisable to draw further on American experience.

BY courtesy of the Secretary of the Colorado Scientific Society, we have received the report of a committee of that society on the revision of the mining law, covering the ballot taken on the questions submitted by the Mining and Metallurgical Society of America, as related in our issue of November 11. A majority of the committee was unwilling to waive the requirement of 'discovery' before location, preferring that possession of a claim be legalized pending a *bona-fide* effort to find ore in place. It

was decided, however, that even if location be permitted prior to 'discovery,' patent should not issue until this requirement, of discovery, has been fulfilled. The committee was divided on the question of one discovery sufficing for more than one of a group of contiguous claims, but it agreed that every claim should be separately marked by monuments. Likewise a unanimous vote was given for placing no limit on the number of claims any person or association may locate. No support was accorded the proposal to compel the recording of claims in the U. S. Land Office, but the suggestion was made that the time for recording with the County Recorder be shortened to 60 days. The suggestion to substitute money payment in lieu of assessment work was not endorsed, nor was the Committee in favor of crediting excess assessment work from one year to the next, but urged that adequate provision be made for ensuring *bona-fide* performance of assessment work, to be valued at the rate of wages current in the particular district. On the main question, the Committee approved the proposal to abolish the extra-lateral right. Not only did it vote against recording in the Land Office, but it approved the suggestion of an appeal from the decisions of the Land Office to a court of competent jurisdiction. These are the main findings and we give them because they represent current opinion among mining engineers in a great mineral region. In the main, they are likely to reflect the views not only of engineers but of many owners and operators of mines. However, they throw no light on the opinion of the prospector and of other humble but extremely useful members of the mining public. Any change in the law is not likely to be made, nor should it be made, without considering the effect of it on the varied interests to be affected thereby; nor should any fresh enactment be passed without weighing carefully the confusion inevitably to arise from the conflict between the new and the old regulations. The old law, defective as it may be, has been filtered through the courts until its intent is clear. Any new law will be difficult to interpret until it also has gone through a protracted baptism of litigation.

The Great Calamity

The end of another calendar year and the coming of the season of goodwill finds civilization in the midst of a murderous conflict that shows no prospect of an end. The early appeal to our sympathy for the victims of ruthless aggression and the instinctive lift given to our imagination when we realized the splendor of sacrifice that was driving thousands into the jaws of death have alike lost their force. The iteration has dulled sensibility. Are we not becoming callous? and is not that callousness more horrible than the horrors of the battlefield? One can read in the daily paper that at Chicago wheat was down yesterday "under the depressing influence of peace talk," and one can hear people on the train or tram say that they are "sick of the War," as they turn a page to read about the latest football match

or the newest scandal in suburban life. Is not that picture more sad than an abandoned trench in which the dead lie five yards apart; is it not more brutalizing than the bomb that falls from a Zeppelin? We think it is. How many of our more intelligent readers have begun to look upon the War as an unnecessary and wasteful quarrel, as other people's quarrels usually seem to those that go about their daily work in normal tranquillity of mind. To such of us as are interested in mining has not the War become the barometer of metal prices and is there not a danger that the cessation of the organized calamity on the other side of the Atlantic will mean to us not a consummation devoutly to be wished but a check to abnormally favorable markets? We have not even salved our consciences with giving money to help the distressed; what we have done is too small to assuage self-contempt. We hear a lot about Belgian relief; out of \$227,500,000 devoted to that purpose, the people of this country have subscribed \$10,000,000—and we eat \$200,000,000 worth of candy annually! A few heroic souls have gone to fight or to drive ambulances, and even these are condemned for their un-neutrality. There has been a lot of petty collecting of money, much of which is typified by the four young women that hunched in aid of a Belgian fund: they subscribed \$1 apiece, but the luncheon cost \$31.50. People must lunch, dine, or dance, they must be amused by song or play, before they will give a dollar—and when they have given a pittance they turn complacently from the untold sorrows of the great nations from which all of them originated. Let the Red Indian ignore the Great War—or the Negro—but not a nation that consists of European immigrants and their descendants. Whether a man's forefathers landed on Plymouth Rock or on Ellis Island, he has some tie with some country in Europe, and he must have a pitiful imagination and a stunted spirit if he cannot give a heart-throb for those, on whichever side they may be, that are risking all that they have and hope in the valley of the shadow of death. Must neutrals be ignorant? must they cease to think and to imagine, while going on their way in a fierce scramble to get all the 'prosperity' that is being created by the misery of the other half of the world? Must we accept the dictum of our wretched morning paper when it says that "as neutrals, we are not concerned to know the merits or demerits of either side"? Surely not; as rational beings we cannot help being keenly interested in the events that are the greatest in human history. This thing at which we look from day to day is no Yaqui uprising in Sonora, it is not a Villa raid on our border, exciting as that may seem to the hysterical reporter; this drama on which we look is the most tremendous episode in the history of the race; it is a privilege to be alive to see it and it is a crime to treat it as if it were a cinema show for children. We are spectators of the greatest calamity that has befallen civilization: the very cradle of what we call modern civilization is being smashed to smithereens, and the peoples that were deemed the most civilized are cutting each other's throats by tens of thousands. We cannot stop it—we

have not the organized force to do so; we cannot call a halt—we have not the moral authority to do that; we can do nothing—for we are neutral; but we can at least be alive to the fatefulness of the conflict and of the part that it must play in the destiny of the world and in that of America. Already the fateful contest has served to disclose the diversity of the elements out of which this nation has been made. The War has been a disintegrating force south of the Great Lakes as it has been an integrating factor north of the boundary. The participant has been warmed to a great loyalty; the spectator has been chilled to a cold misgiving. The temperature of this melting-pot of alien races has been kept so low, by official request, that it is only a mixing-pot, in which the ingredients tend to become mutually repellent. To complete the fusion of the unlike elements—the scrap and the dross as well as the ore and the flux—that have been shipped across the Atlantic to be melted in the crucible of generous democracy, we must have the warmth of a wide charity, the heat of a great ideal, and the fire of self-sacrifice. The cold glare of prosperity will melt nothing; it will only illumine the inequalities of existence and the unfairness of the scramble for wealth. We need the glow of generous sentiment. Let us bow our heads in sorrow for the countless thousands that have seen their homes smashed like a child's toy by the engines of destruction; for the horde of miserable ones whose weary tramp across the devastated fields could almost be heard by us if the more insistent roar of guns did not drown the tread of their tired feet; for the millions of prisoners herded like cattle in barbed-wire enclosures. What is Christmas to these? What is it to the homes bereaved by the loss of husband or son? What is it to the fatherless children and the widowed women that sit beside the dying embers of a winter evening? What is Christmas to the Belgian enslaved by the invader, to the Pole or Rumanian whose hearthstone lies buried amid smoldering ruins; what is it to the Serbian or Montenegrin whose country has been trodden underfoot, or to the wretched Greek who has become the shuttlecock of opposing policies? What is Christmas, what is civilization, what is life to the million Armenians that have been the victims of an organized scheme of brutality and bestiality? We are proud, if we are not patriotic; can we imagine the degradation of spirit that these tragedies bespeak? Think of these; think of the shame of the conquered and the pain of the dispossessed; think of the travail of spirit, the unutterable misery, and the blank despair that is the Christmas portion of millions of fellow-men not far from us; and thinking thus, let us condemn the gluttony of wealth that is making New York a byword; despise the commercialism in Chicago that regrets the whisper of peace; and disclaim the gaiety in San Francisco that ignores a world of sorrow, famine, and murder. If we cannot fight, if we do not give, let us at least on Christmas day pause for one moment and bow our heads in bitter humiliation of spirit that we can do so little to lessen the pain and the suffering that man is causing to man.

Belgian Kiddies

Two days after the foregoing editorial was written we received the circular letter headed 'Belgian Kiddies, Ltd.,' which we publish on another page. It is signed by 60 members of the mining-engineering profession and if time had permitted it would have been signed by 6000 more. We ask our readers to give it their thoughtful consideration and then act forthwith. Is it not true that many of us have soothed our self-respect by admiring the splendid work done by Mr. Hoover and his associates, most of them mining engineers, in Belgium; have we realized sufficiently that the principal gift of America to Belgium has been neither money nor food, but a priceless executive ability in which as engineers we can take pride, of course, because it has been contributed by a distinguished member of our own profession? The circular letter suggests how great has been that gift to Belgium from America but how miserably small has been the financial aid given to the Relief Commission. Is it not time to correct the pitiful discrepancy? Should not our natural pride in the work of the Hoover commission take a more substantial form? Let us then shake the Chairman by the hand and in the act transfer something golden from our hand to his. There is no need to eulogize the great performance of Mr. Hoover—it has become a part of current history; it were better to express our admiration in tangible form. It is not necessary to pour praise on the equally unselfish labors of his associates, but we would like to say that the university founded by Leland Stanford has shown a spirit that places it among the great institutions of human culture—a university indeed. The group of men recruited so largely from California has done a big thing and it is high time for the mining profession to recognize it. The opportunity to do so is given to us now by this appeal in behalf of the Belgian children. 'Belgian Kiddies, Ltd.,' it is called, as if to suggest the prospectus of an undertaking in which big dividends are assured; as assuredly they are—the gratitude of thousands of little ones that can be saved from the sickness threatened by lack of food. The preferred stock now issued in this glorious enterprise is offered at \$12 per share; it is expected to sell 10,000 shares and so to raise \$120,000. With this money it will be possible to provide one meal per day for 10,000 children during the coming year. As the prospectus says, each share sold means 365 square meals for one child. The corporation is organized under the Laws of Humanity and the legality of the issue is guaranteed by the Court of Last Resort. If you subscribe you will have the satisfaction of knowing that the money will be used with maximum efficiency, for the overhead expenses of the Commission for Relief in Belgium are only $\frac{3}{4}$ of 1% of the gross cost. We have no hesitation in urging our readers to respond promptly to this appeal for the little ones that are the pitifully innocent victims of the great calamity. Send your remittances to Belgian Kiddies, Ltd., at 120 Broadway, New York.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Belgian Kiddies, Ltd.

The Editor:

Sir—An informal committee of mining engineers, from all over the United States, is undertaking to give our friend Herbert C. Hoover a Christmas present, by taking off his shoulders part of the burden which he and his associates have been carrying for the last two years and a half.

During this time, the United States has received a great deal of gratitude from Belgian people which it has not deserved. To the Commission for Relief in Belgium all praise is due for its work. The C. R. B.—as it is known—has distributed in Belgium goods costing about \$227,000,000, of which the United States has contributed \$10,000,000, or about 4.3% of the total; and much of this has come from a few large foundations. The commission has purchased in the United States goods to the amount of \$125,000,000. We have not even paid a fair commission thereon. Reduced to a per-capita basis, we have given 8 cents apiece. Canada has given 18 cents per capita, New Zealand \$2.34 and little Tasmania \$6.25 a head. Yet the United States gets most of the credit. We have been obtaining gratitude under false pretenses.

This is naturally discouraging to us who know and appreciate the work of American engineers in Belgium. These men have been keeping alive a population of nine million on one meal a day. This is not enough for children. (Would you like it yourself?) At present one million children are failing in health, and the C. R. B. has asked us Americans to assume the proper feeding of these children as our little share of the big job.

To do this right the C. R. B. has started to give the children a nourishing noon-day meal, and it has not the money to carry it on. This costs only one dollar per month per child (three cents a day). This seems incredible but as the overhead expenses of the C. R. B. are only $\frac{1}{3}$ of 1% of the gross cost you will understand that this is real engineering efficiency.

As engineers we want to show our appreciation and so we have organized an informal syndicate to float a new venture. We would like to cable Hoover before Christmas that we will take a block of "Belgian Kiddies" off his hands. Don't you want to come in with us?

W. H. BASSETT
F. BRADSHAW
D. W. BRUNTON
D. H. BROWNE
R. B. CARNAHAN, JR.
R. M. CATLIN

A. C. CLARK
J. P. CHANNING
F. H. CLYMER
J. V. N. DORR
W. DOUGLAS
H. S. DRINKER

T. C. DUPONT
S. A. EASTON
C. W. GOODALE
J. C. GREENWAY
H. G. HIXON
C. B. HOLLS

R. J. HOLDEN
R. W. HUNT
G. P. HULST
H. JENNINGS
D. C. JACKLING
W. R. INGALLS
W. KELLY
E. B. KIRBY
C. B. LAKENAN
D. A. LYON
J. F. MCCARTHY
C. H. MACDOWELL
G. MACFARLANE
J. MACNAUGHTON

E. P. MATHEWSON
C. G. MEMMINGER
C. W. MERRILL
C. E. MILLS
P. N. MOORE
S. W. MUDD
R. V. NORRIS
H. C. PARMELEE
C. F. RAND
F. B. RICHARDS
R. H. RICHARDS
L. D. RICKETTS
M. ROBERTS
J. C. RALSTON

D. M. RIORDAN
T. ROBINS
T. A. RICKARD
W. L. SAUNDERS
E. A. C. SMITH
F. M. SMITH
J. M. SULLY
T. B. STEARNS
C. R. VAN HISE
W. R. WEBSTER
H. V. WINSIELL
C. W. WHITLEY
I. C. WHITE
P. YEATMAN

Pan-Americanism—A Myth

The Editor:

Sir—I have found your recent editorial (November 18, 1916) under the above heading of especial interest, having myself had experience in South America. With parts of the article I thoroughly agree; some of the arguments set forth, however, seem erroneous, at least merely theoretical. For example, why should an extension of our trade in one direction, south, necessarily result in curtailment in another, east? If commercial intercourse with Europe remains profitable after the War, it will continue. Many of the tropical agricultural products of South America are needed and used in this country. Europe has, in the past, supplied most of the manufactured articles consumed south of Panama, but cannot we, as a nation, with intelligent preparation, make the things needed by South Americans and make them the way they want them in competition with Europe?

I admit the existence of racial, political, legal, social, religious, and educational differences existing between the United States and the South American countries, but has our brother from northern Europe any advantage over us in these respects? Would we be any more of a hermit nation if we broadly took into account all differences, made allowances therefor, and proceeded to overcome any difficulties that might threaten therefrom? The question is, can we, after the War, compete with Europe in South American commerce? If so, we now have an opportunity to take our share of this trade. This question can only be answered finally by the business man who is willing to back up his practical knowledge, confidence, and fearlessness with the investment of his capital.

If we have been hypnotized by a figure of speech let us drop it; but why limit our trade if found profitable in

other directions than the east. Above all let our citizens have protection at home and abroad, let us have our own merchant marine and let us have an adequate navy to guard our coasts and our shipping.

RUSSELL T. MASON.

Los Angeles, December 8.

Electric Heater for Solutions

The Editor:

Sir—A simple and effective electric heater can be made for heating solutions or pulp in a tank from material that may be found around any mine or mill repair-shop.

In running a cyanide test recently it was desired to heat the solutions in an experimental tank that was so situated that no method of heating was available but to use electricity. An endeavor was made to purchase something that would do the work, but nothing could be found locally that was satisfactory, nor could the dealers suggest a heater that would do. After a few trials of

the $\frac{1}{4}$ -in. pipe or a substitute, tying it securely and winding any high-resistance wire around it in a spiral so that the windings do not run together. A convenient way of doing this is to use a lathe with a thread-feed.

This heater was attached to the ordinary lighting-circuit with an extension-cord and could be removed at will. On a 120-volt circuit the current consumed was from 6 to 8 amperes. The pulp reached a temperature of 100° F. in about 8 hours. It is set inside the tank and the heat adjusted by merely turning on or off the current as required. No dimensions are given as each case would involve different conditions.

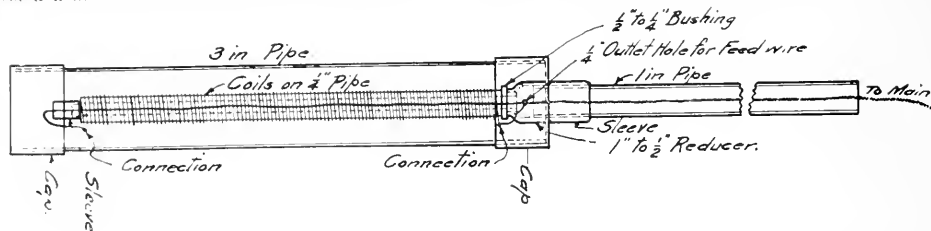
F. DEAN BRADLEY.

Reno, Nevada, December 4.

Effects of Faults on Richness of Ore

The Editor:

Sir—In several different mines operated under my own direction, and in others as well, I have noticed that,



ELECTRIC HEATER FOR MILL SOLUTIONS.

various inventions, the heater shown in the accompanying sketch was evolved.

The container was an experimental tank of the pachuca type 48 in. high by 20 in. diameter with the customary column in the centre so as to permit nothing of broad dimensions to be used. It was necessary to have the heater of greater proportions longitudinally than transversely.

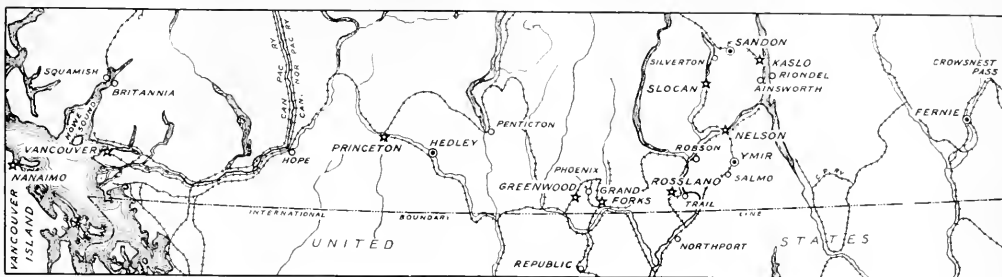
Three resistance-coils from dismantled arc-lamps were secured from the power company's scrap pile, and connected in series. Through the hollow core of these was run a $\frac{1}{4}$ -in. pipe having a sleeve or other connection on the end to form a shoulder. The length of this was such that when screwed into the fitting on the other end it would pull the coils securely together and form a support free from the casing. The details are so obvious from the drawing that further description is unnecessary. The wires must be well insulated and the joints of the pipe tight to prevent leakage of either current or water. If no asbestos-covered wire can be obtained for the conductors inside the heater proper, it is possible to resort to the method used in this case of cutting glass-tubing (found in any mine assay office) into short beads and stringing them on the wire before insertion. Where it is not possible to get coils of the kind mentioned, one may be made by rolling dampened asbestos board around

in most instances where a vein or orebody is intersected by a fault, the continuation of the ore beneath the plane of dislocation is of lower value than that above the fault, and that this condition was present whether the amount of displacement was great or small. In some cases there was found a decided enrichment of the vein or orebody just above the plane of faulting, although this was not always so. I would like to ask if others have ever observed the apparent influence in this respect of faulting on veins and ore-deposits, and what were the conditions where thus observed? The several instances I have in mind were those where the continuity of the orebody was interrupted by dip-faults rather than those approximating the strike of the vein.

San Francisco, November 20.

ENQUIRER.

HIGH EXPLOSIVES, such as dynamite, nitro-glycerine, and similar compounds may not be legally carried in personal baggage on railroad trains or other passenger vehicles. There is a prescribed maximum penalty of imprisonment for 10 years for anyone convicted of this crime when death or bodily injury results from the illegal transportation of explosives. When no injury results, the maximum penalty is 18 months imprisonment and a fine of \$2000.



MAP OF SOUTHERN BRITISH COLUMBIA, SHOWING THE BOUNDARY REGION.

Electrolytic Refining at Trail

By T. A. Rickard

INTRODUCTION. The Consolidated Mining & Smelting Company of Canada is the owner of the smelter at Trail, the only refinery in the Dominion. This metallurgical establishment is remarkable for producing five metals by electrolytic process: gold, silver, copper, lead, and zinc. Several other metallurgical products are manufactured, such as manganese dioxide, sulphuric acid, hydrofluosilicic acid, and copper sulphate.

The Trail plant was built originally by F. Augustus Heinze in April 1896 for the treatment of the silicious copper output of Rossland and the silver-lead product of the Kootenay region. Heinze constructed the 42-inch gauge railway, 10½ miles long, that connects the smelter with the mines at Rossland. The Consolidated Company, as it is known locally, was organized in 1906 to acquire the smelter and the mines, these including the St. Eugene silver-lead mine in the Slovan district and the Centre Star-War Eagle group of copper mines at Rossland. The railway to Rossland passed into the possession of the Canadian Pacific, which also controls the Consolidated Company. The managing director and general manager of the latter is James J. Warren, who likewise is president of the Kettle Valley railroad, now also a part of the C. P. R. system, although operated as an independent line. R. H. Stewart, one of the most highly esteemed engineers in British Columbia, is consulting engineer and has charge of the mining operations of the company. E. H. Hamilton was appointed consulting metallurgist in January of this year and in October he was promoted to manager of smelteries and refineries. The Le Roi mine was bought from the English liquidator of a former company in 1912. In 1909 a lease and option was taken on the Sullivan mine from the Federal Mining & Smelting Co., the purchase of this valuable property was completed in 1911, on the initiative of Mr. Stewart, then general manager for the Consolidated Company. This will prove a decisive episode in the history of the enterprise, for the Sullivan is proving itself one of the big mines of North America. The immense zinc-lead ore-

body in that mine caused the management of the smelter to erect an electrolytic plant in September 1915. At the time of my visit, in August last, this addition had just started to produce the several metals, illustrating many interesting phases of the newest metallurgy. Of the ore now coming daily to Trail, 1000 tons of low-grade copper ore is obtained from the mines at Rossland, while 600 tons of zinc-lead ore is supplied by the Sullivan. Small lots of lead ore are received from the Consolidated Company's own properties in the Ainsworth district and sundry contributions of custom ore are derived from mines scattered throughout the adjacent mineral territory.

The Trail smelter occupies a fine site, on a gravel terrace, backed by high hills and overlooking the Columbia river, here a lordly stream flowing between granitic slopes. At the time of my visit the supply of labor was inadequate owing to the harvesting operations, for which men had been drawn to Alberta on wages of \$3 to \$4 per day. The War, of course, has taken a good many, especially the better class of operatives and members of the technical staff.

The smelter is not bothered by 'smoke suits,' the Consolidated Company having purchased the adjacent land to avoid this very trouble. Now that the operations of the smelter support a community of increasing size and create a market for agricultural products, the farmers are buying back the land under agreements to which a smoke clause is attached.

The main smelting-plant contains five copper blast-furnaces, four lead blast-furnaces, and two 12-ft. basic-lined converters. All except one of the blast-furnaces receive their charge in cars that are dumped by means of latches released on arrival within the furnace itself. One furnace is charged in the old-fashioned way, through an opening in the charge-floor, after the cover, which is on wheels, is pushed away. This work on the charge-floor of a smelter is among the most unpleasant and it deserves all the attention that the metallurgist can

give to it, for the workman's efficiency, physical and mental, is impaired by the fume and smoke. The fact that the men are "used to it" does not alter the fact that their health and efficiency suffer from the escaping fume and dust. Of course, the lead fume is poisonous, but the sulphurous gas is said to be irritating only. Watching the operations of smelting, particularly in the converter department, one realizes that big-scale operations were impracticable before electric cranes became available for the moving of heavy loads.

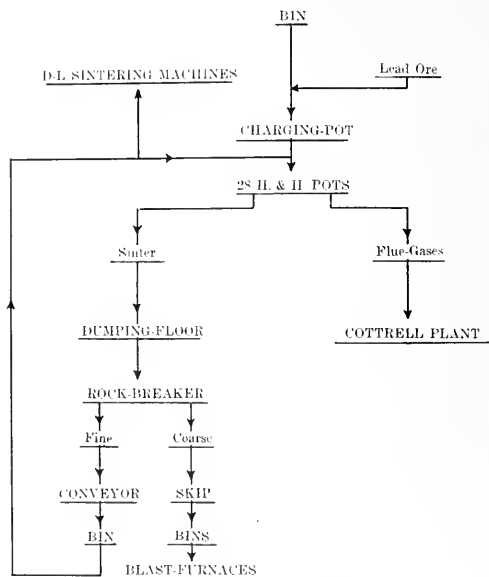
Looking at the interior of a blast-furnace and remembering the great diversity of shape given to this metallurgical unit, one concludes that the shape of a furnace is not so important. It makes its own smelting area.

The distinctive features of metallurgical practice at Trail at the present time are due to the treatment of a large tonnage of zinc-lead ore from the Sullivan mine, which is situated 250 miles north-east of Trail in the East Kootenay district, and about 20 miles north of Cranbrook. It is an old mine, as age is measured in this part of the world, having been opened up in 1888, when it was operated by a local company that built a lead smelter near the mine and went bankrupt. Two or three other companies tried in vain to exploit the mine as a source of silver-lead ore, but the zinc spoiled the operation. The ore is a dense and intimate mineral mixture, part of which appears to be a compound of iron, zinc, lead, and sulphur. Geologically the deposit is an impregnation along the bedding-planes of a flatly dipping quartzite—so I am told by S. G. Blaylock, the assistant general manager. Drill-holes have tested the ore-body for 1400 ft. on the dip, finding a thickness of as much as 140 ft. of ore at the bottom of the bores. The stipes are spread over 3500 ft. on the strike and have an average width of about 40 ft. This is undoubtedly one of the big orebodies of the world and is destined to become famous. An extension of the ore-bearing ground is found in the adjacent Stenwinder mine, which is owned by McKenzie & Mann. The zinc, which formerly was a fatal blemish, has now become an asset, thanks to metallurgical progress and a favorable market.

The Sullivan 'zinc' ore averages 25% zinc, 11% lead, and 3.5 oz. silver per ton, while the Sullivan 'lead' ore runs 14% lead, 12% zinc, and 12 oz. silver per ton. The treatment of the zinc ore is divided into two parts; the ore is roasted, leached, and subjected to electrolytic precipitation, as will be described in detail; then the residue, which contains all the lead and 8 to 10% zinc, is passed to the sintering machines of the lead-smelting department, where it is mixed with lead ores from other sources.

LEAD SMELTING. The Sullivan 'lead' ore is ground to 28-mesh and pre-roasted to 10-12% sulphur in Wedge & Godfrey furnaces, from which it is delivered by a Peck conveyor to a bin made of reinforced concrete. A similar bin receives the leady residue from the electrolytic zinc plant. From these bins the ore mixture is fed into a charging-pot moved by a crane so as to deliver its contents into the Huntington & Heberlein pots, of which

there are 28. Each pot holds 6 to 8 tons. On the bottom a fire of wood slabs is started, and then the ore-mixture is introduced, as described; next the hood is put in place, by the crane, so that the gases can escape into a pipe leading to the Cottrell plant, in which the fume is condensed. The blast being turned on, the ore in the pot is sintered into a porous mass, which is discharged, after 6 to 8 hours, by lifting the pot, by aid of the crane, and moving it to the dumping-floor, where it is tilted and emptied. The lumps are picked up by a 'crab,' or pincers, operated from the crane overhead, and lifted into a large rock-breaker. The fine is taken by belt-conveyor to a bin, where it is mixed with fresh charge and re-sintered either by a Dwight-Lloyd machine or in more 11 & 11 pots; in short, it has to be agglomerated anew,



FLOW-SHEET OF LEAD TREATMENT.

for its finely divided condition renders it unsuitable for smelting in the blast-furnace. The objects of sintering are to reduce the sulphur content and to turn fine material into lumps suitable for the blast-furnace.

Meanwhile the coarse product from the breaker to which the 11 & 11 sinter was delivered is transferred by a skip to the bins above the blast-furnace. A Dwight-Lloyd machine treats material similar to that in the 11 & 11 pots, and treats it in a manner that appeared to me more satisfactory. The 11 & 11 performance looks clumsy; there is much handling of material, too much discharging and lifting. The smoke from the wood-fire and the steam from the wetting of the roasted ore, together with the hammering on the Cottrell tubes, all suggested uneconomic methods. To the technical observer, noise, smoke, and steam do not indicate the last word in metallurgy. On the other hand, the Dwight-



GENERATOR ROOM, ELECTROLYTIC PLANT, AND SUB-STATION.

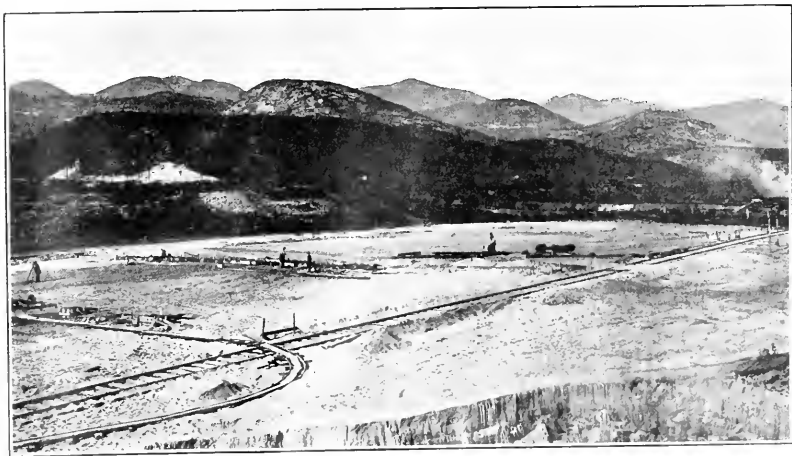
Lloyd sintering machine strikes the visitor as a clever device, in that the hearth, or 'palette,' is so small and the operation so intensified within a restricted area. At Trail each palette has five interlocking herring-bone grates, so that the interior grates are alternately fixed and loose, causing the sintered ore to detach readily when about to be dumped. This arrangement was designed by Mr. Stewart. It means the saving of six men per day on the two machines.

While the tailing from the zinc-leaching plant now goes to the H & H pots, it is intended to try briquetting, which permits the utilization of scrap-fuel such as coke-breeze, ashes, cinders, and other carbonaceous matter after it has been sized by jigging.

The zinc increases the difficulties of the metallurgist. A 10 to 12% zinc ore makes trouble in lead smelting at

many points—in the sintering, for example. In the lead furnace the atmosphere that reduces the lead oxide also reduces the zinc, which is then volatilized as it descends into the region of high temperature and there resumes its condition of fume, which settles in the upper part of the furnace as zinc oxide, forming accretions that encrust the sides of the furnace and makes growths on the walls, culminating in blow-holes that prevent the uniform settling of the charge. Then follows high temperature in spots, causing the lead to be carried into the flue. The smelter limit on zinc nowadays is 5%. This is about right, but it seems strange to see smelter people making an excess of zinc for themselves; it indicates a notable increase of metallurgical resourcefulness.

ZINC ORE. The Sullivan ore is a dense and intimate mixture of blende, galena, and pyrite. Some of it ex-



BREAKING GROUND FOR THE ELECTROLYTIC ZINC PLANT, OCTOBER 4, 1915. RAILROAD GRADE TO ROSSLAND IN BACKGROUND. SMOKE OF TRAIL REFINERY ON THE EXTREME RIGHT.

hibits a banded structure, the component sulphides being differentiated. In looking at specimens, I was reminded of the equally complex ore produced by the Bawdwin mine, in Burma. The average composition of the ore shipped from the Sullivan mine to the zinc plant at Trail during a month was as follows:

	%		%
Pb	13.8	Al ₂ O ₃	4.1
Zn	22.7	CaO	1.0
Fe	24.0	MgO	0.08
S	23.7	Ag	3.7 oz.
SiO ₂	5.4	Au	Trace

On arrival at the smelter this ore is crushed to $\frac{1}{2}$ -inch and then passed through a cylindrical drier, from which it is elevated to bins that feed two ball-mills, each 5 by 18 ft. and having a capacity of 10 tons per hour. They were made by the Traylor Engineering Works. Thus the ore is reduced so that 90% of it will pass 150-mesh. It is then conveyed by belts to the hoppers in the roaster-building and by these hoppers it is fed to a belt-conveyor that passes to bins above the Wedge furnaces.

ROASTING THE ZINC ORE. Eight Wedge furnaces are in operation, each delivering 40 tons of roasted ore daily. Five more furnaces of the same kind are now nearly completed. All of those in use are being fired with coal, but it is intended to substitute coal-dust as fuel. Each furnace has one hearth for drying and seven for roasting; of these, five have air-cooled arms, or rabblers, while on two hearths the rabblers are water-cooled. The doors are used to regulate the temperature, this having been found advantageous. On each hearth are two rabblers, which make one complete revolution in four minutes, sweeping the pulverized ore toward the centre on one hearth and from the centre on the next hearth, alternately.

The critical stage of the roasting is reached on the second and third hearths, where, if the temperature is allowed to get too high, the charge may agglomerate or clog, forming lumps of partly roasted material having an unroasted core, which therefore escapes oxidation and comes out of the furnace in a sulphide condition. The temperature of roasting is kept as near 1200° F. as possible. If the heat is greater the sulphides burn too rapidly, creating nuclei of still higher temperature and promoting the rapid formation of a zinc ferrite, which is only slightly soluble in acid. The aim, of course, is to roast the zinc-blende to an oxide or a sulphate. The roasted product contains about 3 to 5% total sulphur, of which about one-half represents sulphide and the other half sulphate of zinc. The latter is soluble in water. The oxide is readily soluble in sulphuric acid. Any sulphide in the 'roast' is not dissolved in the acid solution; from the leaching-vats it passes into the tailing, which is accumulated for re-treatment in the lead-smelting department.

Condensation of fume from the roaster is effected in 10 in. Cottrell tubes, yielding an impalpable powder, which is wetted before being removed to the furnace-room, where it joins the rest of the 'roast' on its way to the leaching room. This sublimate leaches readily. I

learn that more recently the Cottrell product is being returned to the roasting-furnace, but it is not yet certain which method is preferable.

LEACHING. The sulphuric acid used in the various departments at Trail is obtained from the gas escaping from the Wedge roasters of the zinc plant and also from lump-burners fed with pyritic ore from the Sullivan mine. These burners are the old kilns or 'stall burners' for burning lump pyrite. They are rectangular in plan and have grate-bars. Charging is done by shovel through a door in the front. The chamber process is employed and 12 to 15 tons of acid is produced daily. This acid is available for parting the doré bars, for the production of hydrofluosilicic acid, and for making the electrolyte in both the copper and zinc refineries.

The hot cinder of roasted ore that comes from the bottom of the furnace is spread upon a revolving table, where it is wetted by a spray and thereby cooled before being delivered to the rubber belt of a conveyor that takes it to the leaching-room. The hot oxidized ore coming into contact with the water-spray is subject to incipient solution. Arriving in the leaching-room the so-called calcine,* is delivered into a launder flowing with water containing 4% free sulphuric acid and discharging upon the first of eight Dorr classifiers. The sand is washed and discarded. The slime-overflow is pumped into a Brown agitator (commonly called a Pachuca tank). In the classifiers the solution becomes nearly neutralized and in the pachuca this neutralization is supposed to be completed. The soluble zinc in the roasted ore is dissolved rapidly: in 10 to 15 minutes. The ferrous iron is oxidized to a ferric state and is eliminated; otherwise the subsequent precipitation of zinc in the electrolytic cell would be hindered and the zinc of the cathode dissolved, causing a rise of temperature in the electrolyte.

The overflow from the pachuca is a chocolate-colored liquor; it goes to a Dorr thickener, and the overflow from this to another thickener, for further clarification, yielding a clear solution, or 'electrolyte,' as it is called already, by anticipation. The feed to the thickeners enters as a 4:1 pulp; the underflow emerges with a 1:1 consistency.

This underflow goes to three Dorr agitators, in which it is mixed with fresh acid in order to remove any undissolved zinc; then the pulp is air-lifted to four acid-proof Dorr thickeners where a counter-current decantation system is employed to wash out the dissolved zinc, the reject being final tailing, containing 12% zinc. It is the aim to lessen this zinc to 8%. The decanted solution goes back to the classifiers. The slime is removed by spigot-discharge and pumped into a settling-pond. The sandy residue, containing 25% lead and 12% zinc, is removed in small cars to the lead smelter. The overflow from the thickeners—a clean solution—is passed through a 6 ft. Hardinge mill, which is kept loaded with

*A term that should be restricted to the product that results from the process for removing carbon dioxide from carbonates, not sulphur from sulphides. That is 'roasting.' 'Calcine' is derived from *calx*, lime.

limestone, for the purpose of precipitating iron. From here the solution is raised by air-lift into a settling-tank, the overflow from which passes to a Kelly filter-press and thence to a pachuca, after which it is agitated with cubes of impure zinc (weighing one pound apiece) in cylinders, 6 ft. diam. and 20 ft. long, in order to remove any copper or cadmium. These cylinders are equipped with baffles. The violent agitation keeps the zinc well scoured. The combined copper and cadmium in the Trail smelter amounts only to between 0.008 and 0.01%. From the cylinders, called 'tumblers,' the solution passes through sacks (30 by 36 in.) made of cheap canvas or 6-oz. duck. These are cleaned weekly. Using 180 sacks, 700 tons of solution is filtered daily.

The above describes the operations as conducted at the time of my visit, last August.

The tonnage of solution going out of the leaching-room is measured by a V-notch weir and a float to which a Bristol disc is attached. The new plant, then being erected, to produce 70 tons of spelter daily, and therefore to treat 1800 tons of solution daily, consisted of 9 Brown agitators, 13 (40-ft.) thickeners, 9 (32-ft.) thickeners, 4 (12 by 60-ft.) storage-vats, besides the filter-presses. This plant is now at work.

The leaching process was in course of experimental development at the time of my visit. It will be interesting to note the changes made in the three months since then. Now the roasted ore is mixed with water containing 6% free acid and is then pumped into the first of an 'acid' series of pachuca, each 10 ft. diam. by 30 ft. high. The overflow from the first goes to a second pachuca, then to a third, and a fourth, in series, finally overflowing to four Dorr classifiers. Here the sand is washed and discharged, while the slime-overflow goes to six 32-ft. Dorr thickeners for counter-current washing. The tailing is discharged. The overflow from these thickeners is air-lifted to the first of four 'neutralizing' pachuca, where high-grade roasted ore is added to neutralize the solution thoroughly and to coagulate any slime. If necessary, a small quantity of ground limestone is added at the last pachuca in order to hasten the settling of slime. The overflow from the last pachuca goes directly to three 32-ft. Dorr thickeners, the overflow from which passes to two Kelly presses, by which it is thoroughly clarified. The filtrate is pumped to two 10 by 30-ft. pachuca loaded with granulated zinc, which serves to precipitate the copper and cadmium. The overflow goes to vacuum-filters that collect this copper and cadmium, leaving a filtrate that is fit to be an electrolyte. The underflow of the neutral thickeners is pumped to the first member of the first, or 'acid,' series of pachuca tanks. Robert Vaughan, the superintendent of this department, states in a recent letter that the three main points in the success of the leaching have been:

1. The designing of an efficient diaphragm pump.
2. Thorough neutralization of the solution.
3. Agitation of the clear solution with granulated zinc to precipitate the cadmium and copper.

On August 17 the daily record showed that 223 wet

tons had been delivered into the leaching-room; the moisture averaged 12%, so that the dry weight was 196 tons. This roasted ore contained 25.5% zinc and 5.9 total sulphur, of which 2.4% was present as sulphate. As regards 'sand,' the heading consisted of 73 tons assaying 25.5% zinc, while the tailing of 64 tons contained 14.2% undissolved metal in the sand itself and 1.6% zinc as dissolved loss in the liquid, so that the total loss was 15.8%, the extraction being 48% only. As regards the slime, the 123 tons of heading assayed 25.5%, while the 108 tons of tailing assayed 14.2% undissolved and 1.4% dissolved, so that the total loss in the slime was 15.6% zinc, or 61%. These results have been greatly improved since then, I am informed. Among the agitators the percentage of moisture was 77.71 and 88; the percentage of acid was 0.42, 0.38, and 0.38, respectively; the percentage of iron in the solution was 0.124, 0.095, and 0.095. Recently this percentage has been reduced to 0.002. In the pachuca the moisture was 88%, the zinc percentage 22.8, the acid percentage zero, the iron percentage 0.013. In the various thickeners the underflow ranged from 41 to 54%, while the acid in the underflow varied from zero to 0.38%. The storage of acid was shown as 619 tons of 3.98%. This was the solution applied to the roasted ore. [It averages now 5 to 5.5%.] The difference between head tonnage and tailing tonnage was 9 tons, in 73 tons, or a little over 12%, which represents the zinc extracted.

This outline of the work in its experimental stage is worthy of record. The 'sand' and 'slime' refer to the coarse and fine cinder in the roasted ore. The extraction of the zinc in the Sullivan ore has been improved to 65% since the time of my visit, so I am informed by Mr. Hamilton, to whom I am indebted for many courtesies.

The zinc oxide and sulphate go into solution quickly; 'they have not to be played with,' remarked Mr. Vaughan, as in the cyanidation of the precious metals. The apparatus used, however, reminds one of a cyanide plant. As regards filtration, it will be interesting to ascertain whether a cake of slime can be made thick enough to hold a vacuum. No barren wash is in use, as in cyanidation. The poorest solution contains 2 to 3%; therefore a filtering effect is essential; dewatering will not suffice. The precipitation of ferric hydrate clogs the classifying apparatus; so also the lead oxide, lead sulphate, and lime sulphate have a cementing quality that is annoying. In the Hardinge mill the lime kills any 'latent' acidity and separates the last of the iron. Thus the lime is a useful precaution.

The pumping of 1:1 slime in slightly acid solution is hard on the metal bearings of pumps. The solution is never perfectly neutral. The sulphate of lead made by the action of the acid on lead oxide—as also the gypsum analogously made—tends to be sticky if allowed to settle, as happens during any temporary break-down in the plant. Any difficulty in pumping arising from this cause has been overcome now by the use of diaphragm pumps.

(To be Continued)



CACHE CREEK, ALASKA.



A MAKE-SHIFT SAW-MILL.

The Cache Creek Dredge, Alaska

By Sumner S. Smith

During the past spring the Cache Creek Dredging Co. installed a dredge on Cache creek, which is the first serious attempt at this type of mining in this part of Alaska.

Cache creek is about midway between the Yetna and Susitna rivers, 65 miles from McDougall, a small settlement on the Yetna. It is a tributary of the Kahiltina from the north, the latter flowing into the Yetna 25 miles above its junction with the Susitna. Stern-wheel steamers can run up the river to McDougall, from which point a wagon-road has been made along the east bank of Lake creek to the Kahiltina, where a bridge has been built by the Alaska Road Commission. From this point the summer trail follows the higher ground on the western side of the Peters hills, although the marshes and bogs are so frequent that it is practically impossible to do any freighting over it during the summer. In the winter the road from the bridge follows the river and the northerly bank to Cache creek and then up the creek. The Alaska Road Commission sent an engineer over the district this summer, investigating the possibility of improving the present trail or of building a new trail from Talkeetna, on the Susitna river. The latter route would shorten the haul and it is probable that the Government railroad will be completed to this point during the summer or fall of 1917, permitting a better freight rate than can be obtained at present. The district warrants this consideration, as freighting is impossible over the present summer trail, but the Road-Commission appropriations have been so limited that it has been impossible to serve all districts, however meritorious.

The Cache Creek valley lies between the Dutch and Peters hills and is comparatively narrow in the upper portion, where the dredge is at work. The bedrock is

slate, graywacke, sandstone, and shale with occasional beds of lignite. In referring to this district, Capps states (U. S. G. S. Bull. 520, p. 179): "Next younger in age than the slates are the diorites and granites, and associated dikes of the high range. These cut the slates and so are younger. The slates have undergone contact metamorphism near the large intrusive masses, and the abundant veins and stringers of quartz that are present for several miles from these bodies are probably the source from which the gold of the placer districts is derived."*

The dredge equipment and timber were assembled at Seattle in June, 1915, and towed to Anchorage on the old sailing-vessel *Garden City*. The stern-wheel steamer *Lois* was also built at Seattle and brought to Anchorage at the same time under her own steam, as the facilities for handling barges across Cook inlet and up the Susitna and Yetna rivers were totally inadequate at that time. At Anchorage, the equipment was transferred to barges that were pushed up the Susitna and Yetna rivers to McDougall. Here the dredge-timbers were framed and during the following winter (December to April) the entire outfit was hauled on bob-sleds from this point to Cache creek, 12 miles above its mouth, where the dredge was assembled this spring and started operations on July 7.

The creek is comparatively shallow, the average depth being approximately six feet, so the dredge was built with a large hull to secure a shallow draft. It is 87 ft. long, 54-ft. beam, and 7 ft. deep. The planks on the bottom are 4 by 12, those on the sides 6 by 12 and those on the deck 3 by 12. The winch-deck is 30 ft. above the main deck, and the pilot-deck 12 ft. above this.

*Note the unnecessary plurals in this quotation.—EDITOR.

There are sixty-five 7-cu. ft. close-connected buckets with manganese-steel lips; and, while the dredge has a capacity of 3000 cu. yd. per 24 hours, the management has based its plans on 2000 cu. yd. only, on account of the shallowness of the ground and the number of boulders. Though the latter have retarded the speed of digging, they have not proved a serious hindrance, as they

Power is furnished by a 250-hp. Yarrow tubular boiler, burning coal, which is mined locally. A 150-hp. Reaves engine drives the pumps and dynamo, a 125-hp. Lidgerwood the digging-ladder, and a 20-hp. the winches. The steam from the engines is condensed and returned to the boiler.

A number of beds of lignite outcrop on Cache creek and its tributaries, and from these an ample supply of fuel may be obtained at a low cost. The company has secured a free-use 10-acre permit to mine coal and this summer obtained its supply from an open-cut two miles from the dredge. This haul will be obviated the coming season, as a contract has been let to drive entries and to open rooms on a 5-ft. bed on Cache creek during the winter, so a supply will be easily available at a convenient point in the spring. The coal has a long flame and is good for making steam, though the percentage of ash is high. If the company had not owned the steam-equipment before the construction of the boat was planned, the situation would have been ideal for an electrically-operated dredge, the power being generated at

the point where the coal was mined.

After a short, though successful season, the only change planned on the dredge is to add a second bull-wheel so that the drive will be on both sides of the bucket-line, which it is believed will reduce friction and

are not large enough to require special apparatus for handling them. With the present number of buckets, the dredge will dig 30 ft. below the water-line, though it is improbable that it will be called upon to work at anywhere near this depth on this portion of the creek.

The fine gravel from the buckets falls through an 11-in. grizzly into a 48-in. flume, 108 ft. long. The grade of the flume is adjustable, though the best results are obtained by keeping it at an inclination of about 1½ in. per foot. The riffles are 2 by 4's, capped with ¾-in. manganese-steel plates and are set 1¾ in. apart. A 6-in. centrifugal pump supplies wash-water at the grizzly and an 18-in. centrifugal pump discharges directly to the flume. The buckets are washed clean by water from two nozzles, the gravel falling to a save-all sluice equipped with Hungarian riffles. This flume is 18 in. wide set on a grade of one inch per foot.

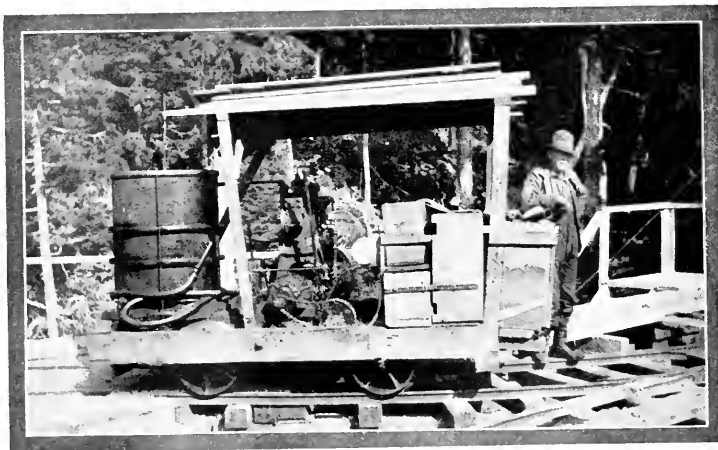
A feature never previously used on an Alaskan dredge is the construction of rock-chutes from the grizzly. The oversize from the bars goes to a Y, the branches of which pass on each side of the save-all sluice and empty in the pond aft of the dredge, where the stones form a dam and prevent the fine from filling the pond under the boat. These chutes are 42 in. wide and lined with manganese-steel plates at the points of greatest wear.

give the dredge a marked increase in efficiency, with a corresponding decrease in operating cost.

THE CONSUMPTION OF POTASSIUM CYANIDE by the mills of the Black Hills in 1915 was 11,477 lb. and of sodium cyanide 485,300 lb. It required 13,900 lb. of quicksilver to supply the gold mills, nearly all of which was used in the Homestake mills.



THE CACHE CREEK DREDGE.



NECESSITY IS THE MOTHER OF INVENTION.

A Matter of Principle

The following is an excerpt from the minutes of the meeting of the Board of Directors of the American Institute of Mining Engineers, on November 24.

MANUSCRIPT OF W. H. SHOCKLEY. The Pennsylvania Anthracite Section, through Vice-Chairman Edwin Ludlow, presented the answer of that Section to the criticism of the San Francisco Section. The following resolution was then passed:

WHEREAS, this Board of Directors on June 23, 1916, instructed the Secretary to telegraph Mr. Durand, the Chairman of the International Engineering Congress, as follows:

"Voted that it is the sense of this meeting that if the paper of W. H. Shockley to the International Engineering Congress which has been objected to cannot be changed to meet the views of the Pennsylvania Anthracite Section, it should not be published."

Now Therefore be it Resolved, that the Directors of the Institute regret that the language of the above message was considered unwarrantably mandatory in tone and assure the San Francisco Section that there was no intent on their part to arbitrarily censor, or cause to be censored, Mr. Shockley's paper, and refer the Section to the letter of President Ricketts to C. W. Merrill, dated November 25, 1916, which is hereby approved. [This letter follows.]

12 Broadway, New York City,
25 November, 1916.

C. W. Merrill, Esq.,
121 Second Street,
San Francisco, Cal.

My dear Mr. Merrill:

I feel, and have always felt, that Mr. Shockley's intent is not to be impugned, and I have never questioned his good faith in presenting the figures he did, but I did feel that he was not, and is not, personally thoroughly familiar with the anthracite district. On the other hand, I am inclined to put great weight upon the statements of eminent engineers of like high character, bearing on matters of fact in their own particular field.

After investigation I felt, and feel, that the figures quoted by Mr. Shockley are not average figures, and while official in that 'in the catalogue' they go as such, they are not really representative, and other figures are available and could have been found which are representative and official.

I readily admit that the form of our resolution was crude, badly expressed and not in accordance with the thought we intended to convey, and I for one will be very, very glad to see it withdrawn. What I thought we were saying was that in our opinion the figures in question did not represent the facts, and that therefore they should not in our opinion be published. I thought from Mr. Shockley's and Mr. Durand's letters, which you have, that this matter had been adjusted satisfactorily, and as you know, Mr. Shockley permitted his paper to be published and expressed his acquiescence in having it published in its present form.

Personally I feel very deeply the criticism of the San Francisco Section. I feel that we are culpable to a certain extent. We have been careless in form rather than in fact, and are to blame. On the other hand, I regret a certain cynicism and lack of faith in me and my associates, shown by the resolution

of the San Francisco Section, giving me and the parent institution no chance of a previous explanation before condemnation, and I believe that my good friends and associates, including Mr. Shockley, for whom I have the highest regard, will upon consideration see the justice of my position.

Yours very truly,

L. D. RICKETTS,
President.

The foregoing was presented by Mr. Merrill to the San Francisco Section at its regular monthly meeting on December 12; whereupon the following resolution was passed unanimously:

"Voted that having heard the resolution of the directors of the Institute, including the friendly message from our President, we appreciate the expression of regret, we desire to reciprocate the goodwill indicated thereby, and we are glad that the incident is now satisfactorily closed."

MINE VENTILATION has an important bearing on the cost of producing ore. Impure air, together with excessive heat and high humidity, not only seriously affect the efficiency of the miner, but they may impair also his health and safety. These facts are of sufficient importance to warrant the close attention of every metal-mine operator who wants to reduce his costs to a minimum. In recent years this subject has been given much thought by large metal companies in various parts of the United States. Many of them now employ men whose chief duty is to see to the proper ventilation of the mine. In many cases fans have been installed, at great expense, in order to secure better ventilation. The following case will serve to illustrate how the cost of production may be increased through poor ventilation; according to the investigations of the U. S. Bureau of Mines: A certain large mine produced approximately 1000 tons of ore per day at a cost of \$1000. The labor cost was \$750. The working-places from which 300 tons of this output came were poorly ventilated. On account of the poor air and the heat in this part of the mine (85 to 90° relative humidity 95 to 100%), it was estimated that the miners put in only one-half of their time in effective work. These miners would have produced 600, instead of 300 tons, had conditions been normal, thus increasing the total production of the mine to 1300 tons per day. This would have reduced the labor cost from 75 to 57.7c. per ton. This illustration is conservative. In a great many deep mines an even greater saving could be effected through improved ventilation.

MOLYBDENITE, the di-sulphide MoS_2 , is the only molybdenum mineral of importance. It contains 40% sulphur, the remainder metal. The mineral belongs to the acid-forming elements, and frequently occurs in granite, though also known in limestone, schist, and other rocks.

Plant of the Babilonia Gold Mines, Nicaragua

By S. M. Parker

CRUSHING. The ore is delivered to the mill-bin from the mine in cars of 1500 lb. capacity. It is iron-stained quartz containing fine free gold, invisible except in some of the high-grade. This ore is about half clay and half rock, so that in the wet season it is difficult to handle on account of its excessive moisture.

The ore is dumped over two grizzlies with 2½ in.

lasts about three months. These pawls are made at the mine and cost very little.

The mills are two No. 3 Holman pneumatic stamps, consisting of a stem or piston carrying a boss-head and shoe, and working in a cylinder hung by two arms from a crank-shaft. In the walls of the cylinder are four rows of holes, two above and two below the centre position of the cylinder. When working with a new shoe, rows two and four are plugged and as the cylinder travels up and down it traps air between the piston and cylinder-head. This air on the return stroke is compressed, acting as a cushion, and also assists in the propulsion of the stem. As the shoes and dies wear, the plugs are changed to rows one and three. The stamps drop 145 to 150 times per minute, depending on the class of ore.

Cyanide solution is fed to the mortar-boxes around the stem in a shower, which helps to keep the sand out of the lower guides. In order to increase the tonnage it was found necessary to add solution to the throat of the mortar-box. The ratio of solution to ore is 9:1, 1.6 lb. sodium cyanide and 0.5 lb. lime per ton, and \$1.56 gold per ton. Lime is added in the mill-bin at the rate of 10 to 15 lb. per ton of ore.

The screens used are the Tyler double-crimped steel-wire of 6, 7, 8, and 9-mesh, as needed. The average stamp-duty per 24 hours from August 1915 to May 1916 was 25.08 tons. From January 1916 to May 1916 it was 27.84 tons.

Mortar-liners last about 4 months; stems, 3 months; and screens, 3 days. The wear of shoes is 0.48 lb. and of dies, 0.17 lb. per ton of ore crushed.

SCREEN-ANALYSIS OF BATTERY-PULP

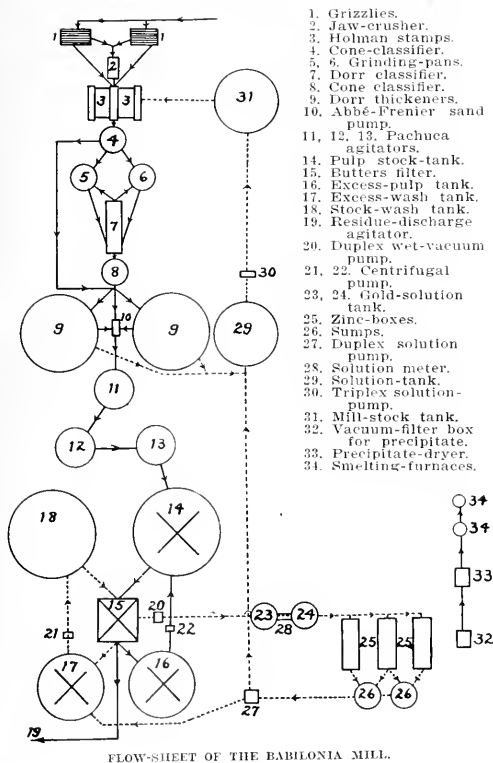
Mesh	By weight,		Value	
	%		per ton	proportional value per ton
20	50.63		\$10.00	\$5.063
40	15.95		8.80	1.403
60	8.67		6.00	0.520
80	4.14		5.60	0.232
100	4.10		6.80	0.278
150	3.61		10.00	0.361
200	0.92		8.00	0.074
200	11.90		8.80	1.047

\$8.978

66.58% by weight is coarser than 40-mesh and contains 72.02% of the gold.

GRINDING AND CLASSIFICATION. The battery-pulp passes through wooden launders to a pointed box with an ascending stream of solution, which separates about 20% of the fine in the overflow, which passes direct to the Dorr thickeners, the underflow going to the grinding-pans.

The grinding equipment consists of two 5-ft. Fraser



spacing, the oversize passing through a 10 by 19-in. Gates jaw-crusher, set to crush to 2½ inches. The crushed rock joins the fine in the bin. The crusher consumes 6 hp. and has had only one set of jaw-plates in 10 months.

STAMPING. The crushed ore is fed to the stamps by two suspended-type Challenge feeders. Originally these were equipped with the Dale patent friction-feed, but on account of not being able to handle the wet ore they were equipped with a pawl, gripping on the edge of the friction-wheel. This arrangement has given entire satisfaction, the only wearing part being the pawl, which

& Chalmers pans making 54 r.p.m., and fitted with Free-man's classifier-overflow.

SCREEN-ANALYSIS OF PAN-DISCHARGE

Mesh	By weight, %	Value per ton	Proportional value per ton
20	5.96	\$13.40	\$0.798
50	6.50	9.04	0.588
60	12.98	6.20	0.805
70	13.40	5.70	0.764
80	8.21	5.50	0.452
100	18.78	5.50	1.033
150	11.33	7.70	0.872
200	3.04	14.80	0.450
- 200	19.31	14.50	2.800

\$8.562

The pans require 7.5 hp. each. A set of shoes and dies lasts from 24 to 26 days. Wear of shoes is 3.22 lb. and of dies 4.41 lb. per ton of ore. The consumption of metal is excessive as the shoes and dies do not wear evenly. From 1½ to 2 in. of metal remains in the dies when the shoes are entirely worn out. A new set of shoes is sometimes used with the old dies, the shoes requiring about three sets of old dies. However, using them in this way causes excessive loss of time in changing dies and grinding a poor surface. New models have been made, having more metal in the shoes and less in the dies, and it is expected that these will wear evenly.

When shoes and dies are new the return-sand to be re-ground is about 5%, increasing to about 15% as the pans wear. The pans discharge to a simplex Dorr classifier, which returns the sand and delivers the slime to a 5-ft. cone.

In order to overflow as much—60 mesh material as possible, the rake was raised and run at the rate of 24 strokes per minute. A spray was also added to help separate the fine.

SCREEN-ANALYSIS OF CLASSIFIER-PRODUCT

Mesh	Feed	Sand	Slime
	By weight, %	By weight, %	By weight, %
40	0.21	3.42	0.20
50	2.71	6.47	1.45
60	5.85	18.75	3.87
80	15.60	35.55	14.32
100	19.05	26.12	15.35
120	4.38	3.20	3.57
120	50.13	6.11	60.85

The overflow is good, but the sand still contains 28.61% of minus 60-mesh product.

From the 5-ft. cone, receiving the overflow of the Dorr classifier, the underflow goes to an Abbé-Freder sand pump, and the overflow to the Dorr thickeners. The object of this cone is only to remove the coarse sand and avoid sending it to the thickeners.

The Dorr thickeners are two 9 by 17 ft. tanks with an area of 454 sq. ft. The speed of the rakes is one revolution in five minutes. Settled slime is drawn intermittently with an average specific gravity of 1.40. This slime is passed to the sand-pump before mentioned and joins the sand from the cone, being then elevated to the Pachuca tanks, or Brown agitators.

The clear overflow from the thickeners carrying an average of \$1.14 is pumped back to the mill stock-tank by a 6 by 8 in. triplex pump.

AGITATION. The Pachuca tanks are three 8 by 32-ft. tanks connected for continuous treatment. The specific gravity of the pulp averages 1.42; it is agitated for 24 hours.

Cyanide strength is maintained at 24 lb. NaCN per ton of solution, by adding solid cyanide in a basket under the overflow of the air-lift. Air-pressure is maintained at 21 lb., each tank using 28 cu. ft. of free air per minute. Consumption of cyanide is 0.7 lb. per ton of ore.

From the agitators the pulp passes to a 20 by 6-ft. stock-tank equipped with a mechanical agitator.

FILTRATION. The filter is a 21-leaf vacuum-filter plant, constructed on the gravity-system and having a filtering-area of 1890 sq. ft. The vacuum is maintained at 21 inches by a 7½ by 7-in. duplex wet-vacuum pump, requiring 5 hp. This pump has done good service for nearly two years, two valves being replaced but once in this time.

The average thickness of cake obtained is 1½ in. A 2½-in. air-lift is used to keep the sand from settling, discharging to a distributing-laundry. In order not to crack the cake on transferring pulp and wash-water, the vacuum is reduced to 15 in. No water-wash is used. To discharge the cake, water and air are blown-in together. The cakes fall into a cement tank with a revolving-arm agitator, which mixes the pulp with enough water to discharge it to the river.

FILTERING CYCLE

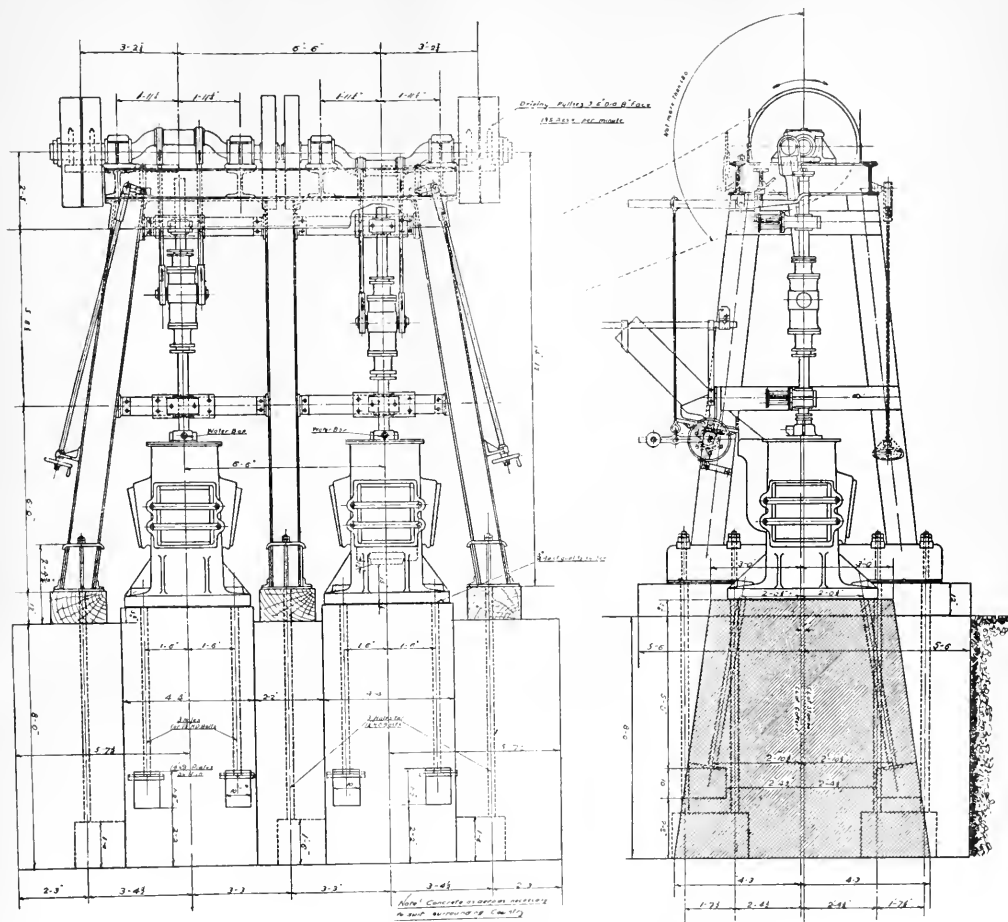
	Minutes
Filling	3
Filtration	32
Emptying	3
Filling wash-solution	3
Wash period	134
Discharge	15
	190
	Cents
Value of wash-solution	7
Effluent wash at end of 90 minutes	34
Effluent wash at end of 120 minutes	10

The average life of the leaves is 12 months. They are treated in a 1% hydrochloric acid solution, four leaves being changed every week. Consumption of acid is 0.19 lb. per ton of ore treated. One man spends half his time repairing and washing the leaves.

The pulp in the residue-agitator is agitated 45 minutes, its volume and specific gravity being measured. From these data the daily tonnage is calculated.

PRECIPITATION. The pregnant and wash-solutions are measured by a meter and go to two 12-ton gold-vats, each containing four filter-leaves, filtering by gravity.

Solution is then distributed to pass through three zinc-boxes, each containing nine compartments, and is precipitated on zinc shaving. Approximately 170 tons of solution is precipitated daily, or 1.5 tons of solution per cubic foot of zinc. Consumption of zinc is 0.5 lb. per ton of ore.



FRONT AND END ELEVATION HOLMAN PNEUMATIC STAMPS SHOWING CONCRETE BATTERY-BLOCKS.

The barren solution is run partly to the wash-circuit and the remainder pumped by a 5 by 15-in. duplex pump to join with the overflow of the thickeners, where it is pumped to the mill-stock tank.

Boxes are packed every 3 to 5 days, moving the zinc up to the head compartments and adding new zinc in the lower ones. Average value of barren solution is 9c. per ton.

CLEAN-UP AND SMELTING. The precipitate is collected at the end of every month and filtered on a vacuum-filter to about 25% moisture. It is then dried, fluxed, and smelted in two oil-burning furnaces.

FLUX

	Parts
Precipitate	100
Carbonate of soda	20
Borax glass	25
Sand	2

The smelt requires from 14 to 16 hours.

The slag produced is granulated and amalgamated in a small barrel, the resulting amalgam being added to the next month's smelt. The residue from amalgamation is assayed and kept for future treatment. Average value of slag after amalgamation is 92c. per pound.

Experiments have proved that by agitating five days in a solution of 6 lb. of cyanide per ton, an extraction of 70 to 75% can be obtained. This method of treatment will probably be followed in the future.

SAMPLING. Battery-head samples are taken every half-hour from the feeders. Every eight hours the sample obtained (about 200 lb.) is crushed and quartered to a suitable size for the assayer. The daily head-value is calculated by multiplying the time run by the assay-value and dividing by the total time run.

Samples are taken from the residue-agitator-tank at every discharge of the filter. In order to obtain an average sample the valve is opened and a small can is used to dip out a portion of the stream, from time to time,

until a five-gallon oil-tin is filled. This sample is mixed thoroughly and the specific gravity determined. Every eight hours this sample is changed, its specific gravity taken, filtered, and washed. The filtrate is assayed for soluble gold and the washed cake for insoluble. The value of the residue is the number of tons of dry pulp, multiplied by the assay-value of the undissolved per ton, plus the tons of solution in discharge, times value of the soluble gold, the total being divided by the tonnage treated.

Solution samples are taken at the top and bottom end of the zinc-boxes. On packing the zinc-boxes at the close of the month, a sample of zinc returned to the boxes is assayed.

The 'gold recovered' is the sum of the bullion produced, plus the value of zinc replaced, plus values of pulp and solution in circulation, plus value of slag.

The 'gold called for' is the assay-value of the ore, less the residue-value, plus the value of the zinc, pulp, solution, and slag of the previous month. The difference is the over or under-production.

POWER is furnished by three 25-hp. suction-gas engines and one 60-hp. engine. In the wet season a Pelton water-wheel furnishes about 35 hp. There are two gas-

producers burning charcoal, one only being used at a time.

(GENERAL REMARKS. It was shown by the experimental work that crushing to pass 60-mesh gave the most economical results. Finer grinding will reduce the value of the residue somewhat, but the increased cost of grinding will more than offset this gain. The plus 60-mesh product in the residue averages 1.6% by weight for the last 10 months.

Extraction is shown as follows:

	Extraction, %
Battery	1.0
Pans	5.0
Dorr thickeners	38.5
Agitators	49.0
Filters	1.0
Total	94.5

The Holman pneumatic stamp is an excellent mill for coarse crushing, although the capacity decreases rapidly when using screens finer than 12-mesh. It is a good machine for small properties where freighting is done by animals, no part being excessively large, especially in the No. 3 mill with its built-up mortar-box.

COST FOR AN AVERAGE MONTH PER TON OF ORE

	Rock breaking	Ore haulage	Milling	Grinding and classification	Agitation	Filtration	Precipitation and smelting	Total
Labor and salaries.....	\$0.134	\$0.080	\$0.262	\$0.066	\$0.090	\$0.126	\$0.032	\$0.790
Power	0.032	.....	0.204	0.092	0.180	0.106	.....	0.614
Repairs and maintenance.....	0.002	0.022	0.080	0.004	0.026	0.010	.....	0.144
Assaying .....	.....	.....	.....	.....	0.126	.....	0.004	0.130
General expense	0.044	0.020	0.080	0.018	0.026	0.038	0.012	0.238
Cyanide .....	.....	.....	.....	.....	0.166	.....	.....	0.166
Lime .....	.....	.....	.....	.....	0.200	.....	.....	0.200
Shoes and dies.....	.....	.....	0.052	0.490	.....	.....	.....	0.542
Filter cloth .....	.....	.....	.....	.....	.....	0.040	.....	0.040
Zinc .....	.....	.....	.....	.....	.....	.....	0.116	0.116
Acid .....	.....	.....	.....	.....	.....	0.012	.....	0.012
Sundry supplies	0.004	0.010	0.032	0.012	0.008	0.002	0.016	0.084
Total	\$0.216	\$0.132	\$0.710	\$0.682	\$0.822	\$0.334	\$0.180	\$3.076

A total of 1615 tons of ore was treated.

A Local Magnetic Pole

The magnetic poles of the earth are commonly supposed to be diametrically opposite each other, and that a line through the earth connecting them would necessarily pass directly through the earth's centre. Such, however, is not the fact, for a line connecting the north and south magnetic poles passes beneath the Pacific Ocean and about 750 miles to one side of the centre of the earth. The north magnetic pole is on the west coast of the Boothia peninsula, opposite the north point of King William's Land, an island, just above latitude 70° north and longitude 95° west. It is interesting to know that there is a centre of magnetic attraction—a local magnetic north pole, at Treadwell Point, near Juneau, Alaska. Observations were made there in 1900 and again in 1907. A tent was erected at a spot where the dipping-needle stood vertical with its north end down, and the compass

reversed its direction when carried from one side of the tent to the other. Ship's compasses, a mile away, in Gastineau channel, are deflected about 11° by this local magnetic attraction.

SUCCESS IN SMELTING requires a careful study of the slags. If the slags are suitable the smelting operations are likely to prove successful. The things to be carefully considered and watched are the melting-points of the various constituents of the charge; these determine the amount of fuel necessary; the viscosity of the slag, which is important, as it must be low or the valuable minerals in the form of matte, speiss, or metal, will not readily separate from the earthy minerals of the charge. The chemical composition of the slag must be such that it will not dissolve large quantities of the valuable metals present in the ore, and occasionally it is required to remove detrimental substances from the charge.

Gold Mining in Korea

By E. W. Mills

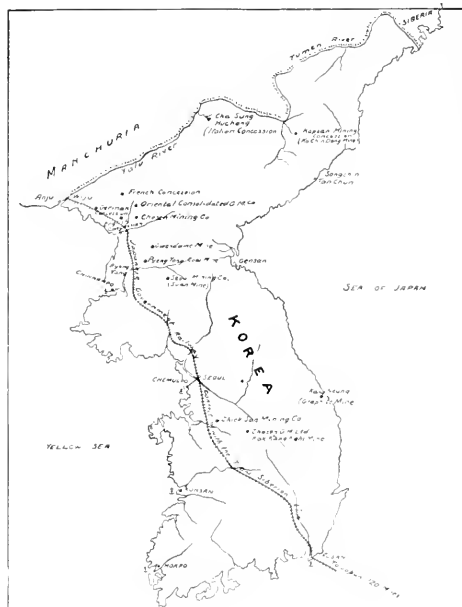
*In the course of a long paper contributed to the Korean branch of the Royal Asiatic Society, the history and present position of gold mining in Korea was given. The author has personal knowledge of all the gold districts during 13 years' experience, and from a personal connection with the three chief gold-mining companies, the Unsan, Suan, and Chiksan. The Unsan mines are situated in North Pyengan, 40 kilometres south of the Yalu river. The Suan mines are situated some 100 kilometres farther south, about the middle of south Pyengan, while the Chiksan mines are situated about the same distance farther south in the province of Kyong-Ki, adjacent to Namyang bay.

The development of production in recent years has been rapid. In 1895 the output first passed the £100,000 mark, while in 1913 it was valued at £1,035,391, in 1914 £1,023,398, and last year it attained the record yield of £1,229,621.

Gold mining is of ancient origin in Korea, going back probably before the Christian era. This branch of mining, however, was entirely alluvial, and it has been overshadowed of late by the development of lode mining under modern conditions. The first concession to foreign engineers was the Morse in 1895. Subsequently, concessions were granted to British, German, French, Russian, Japanese, and Italian representatives. The following is a short account of the leading mines now operating:

UNSAN CONCESSION. This property is being worked by the Oriental Consolidated Mining Co., an American company, which has been highly successful in its operations in this district from the beginning. Operations were first started at Chittaballie, and a 20-stamp mill was placed in operation in 1897. This mill was the pioneer of the modern stamp-mills in Korea. Before the mine was abandoned, in 1905, it had produced 152,632 tons of ore, valued at ¥3,036,952. In 1899 a 40-stamp mill was erected at Tabowie, and in 1907 was enlarged to 80 stamps. To June 30, 1915, this mine has produced 1,226,859 tons of ore, valued at ¥15,918,755. A 20-stamp mill was erected at Kuk-San-Dong in 1900. It was increased to 40 stamps in 1905. This mine was closed down on January 15, 1915, after having produced 551,892 tons of ore, valued at ¥4,788,182. In 1902 a 40-stamp mill was placed in operation at Maibong. To June 30, 1915, 412,071 tons of ore, valued at ¥5,967,274, has been produced. In 1903 an 80-stamp mill was erected at Taraeol. To June 30, 1915, this mine has produced 1,173,208 tons of ore, valued at ¥13,749,526. There are 16 batteries of five stamps each, and 32 vanners of the

Frue type. The daily capacity of this mill is 350 tons. In 1908 a 10-stamp mill was placed in operation at Candlestick. From this mine 43,998 tons of ore, valued at ¥999,591, has been produced up to June 30, 1915. As may be seen from the foregoing, the growth and development of this concession has been exceedingly satisfactory. On July 1, 1915, a total of 210 stamps was in operation at the following mines: Tabowie, 80; Taraeol, 80; Maibong, 40; East Candlestick, 10. The amount of ore crushed for the year ended December 31, 1915, was



295,379 tons, valued at ¥3,758,135. From this ore, gold in bullion and concentrate was recovered to the value of ¥3,228,941. The total tonnage of ore produced from the various mines since 1897 to December 31, 1915, has been 3,986,772, valued at ¥49,568,632. The first dividend of 5% was paid in 1903. Since that time to July 1, 1915, total dividends have amounted to 150% of a total of ¥12,871,550.

SUAN CONCESSION. This British concession is held by the Korea Syndicate, Limited, of London, but is being operated by the Seoul Mining Co. This concession is being developed with highly successful results. Although not as old as the Unsan, its tonnage and output are increasing yearly. It shows promise of eventually becoming the largest producer in Korea. The first mill of 20

*Abstract from London Mining Journal.

£1 = \$4.85.

¥1 = 50 cents.

stamps was placed in operation in the latter part of 1909 at the Suan mine. This mine developed satisfactorily, and the mill was increased to 40 stamps in the autumn of 1911. During the past three years a larger mine than the Suan mine has been developed at Tul-mi-chung, six miles south of Holkol. A reduction plant, the pioneer of its kind in Korea, was placed in operation late in September 1915. This plant has a rated capacity of 350 tons in 24 hours, and is the first one in Korea to use Hardinge ball and pebble-mills, in place of ordinary gravity stamps, for crushing and grinding ore. Both plants also employ the oil-flotation process for the recovery of concentrate. It is expected that the production of gold from the Suan concession for 1916 will approximate a total of Y2,500,000. For the year ended December 31, 1915, the Suan concession produced 108,078 tons of ore, valued at Y1,789,224. The gold production for the same period amounted to Y1,435,041. Since the date of the commencement of milling operations in 1909 to January 1, 1916, the Suan concession has produced 433,361 tons of ore, valued at Y7,945,328, with a total gold production of Y6,566,244. Dividends for the same period amounted to Y2,180,987, or a total of 275%.

CHIKSAN CONCESSION. This concession was operated intermittently by the concessionaires, Shibusawa-Asano Mining Partnership, on a small scale until 1906. In this year American partners were admitted, and in 1907 a small stamp-mill was placed in operation. In 1911 a re-organization took place, whereby the control of the concession rights was taken over by an American company, the Chiksan Mining Co. During the Japanese régime considerable work was done on the placer deposits, and a small profit was made. Although no exact figures are available, it is probable that the alluvial gold production during this time amounted to over Y300,000. For the year ended December 31, 1915, the production of gold from this concession was Y933,261. It is estimated that the Chiksan concession has produced Y3,199,073 in gold, and has treated 192,141 tons of ore during the period from February, 1908, to January 1, 1916. This concession has now reached the dividend-paying stage, and is being operated successfully. The present company has proved the existence of a large acreage of ground containing sufficient gold to warrant the installation of a gold dredge at Sei-go-ri, which was worked earlier under the supervision of the Japanese concessionaires. The order has been placed for this dredge, and it is expected that it will be in operation before the end of 1916. Chiksan will, therefore, have the distinction of starting the first gold dredge in Korea. The operation of this boat, in conjunction with the present mill of 10 stamps, should result in showing considerable increase in the gold production for 1916 and for several succeeding years. It is probable that some monazite may be recovered by the dredge.

JAPANESE ENTERPRISES. Under Government encouragement an important combination was formed in recent years known as the Furukawa Partnership Co., which holds some 15,000 acres in the Koo-Sung district, north

Pyengan. The chief interests comprised are those of Messrs. Furukawa, Asano, and Kuhara. In co-operation with this company, the Kuhara Mining Co. of Osaka, lately completed a smelter at Chin-nam-po, designed primarily to treat gold-copper ores, more especially the concentrate, from the Suan mines.

GOVERNMENT MINES. The Japanese government has itself retained a number of gold prospects for experimental working in different districts.

In all, about 50,000 Koreans and several thousand Chinese and Japanese are now dependent on the foreign companies for their livelihood. The author states that Japanese authorities are willing to assist foreign mining companies in every possible way. After the occupation of Korea, mining regulations were issued in 1906, with further amendments in 1907 and 1908, and a further revision is expected to be published shortly. Henceforth it is provided that "none can enjoy mining rights other than subjects of the Empire or juridical persons organized in accordance with the laws and ordinances of the Empire." It is stated, however, that foreigners who already possess mining rights will not be affected by the revision either now or in the future.

The author concludes that the outlook for a continued increase in gold production is promising, more especially from the successful development of large, low-grade auriferous deposits.

MINE TIMBERS submerged in water will endure indefinitely. This fact is being demonstrated at the Anador Consolidated mine, at Sutter Creek, California, where the timbers of the shaft near the 1000-ft. level are found to be as sound as when put in place nearly 40 years ago. The mine has been idle about 35 years, the workings during this time having been filled with water, which has preserved the timber. The heavy swelling-ground that ordinarily so quickly crushes the timbers in the mines of the Mother Lode in Anador county has little effect when the workings are flooded. This seems to prove that the swelling of the rock is due to exposure to the air, otherwise the process would continue when submerged in water. It suggests that the swelling of the ground that is the cause of so much expense might in some measure be prevented if the surface of the rock, in drifts and shafts, for instance, were plastered with a cover of cement-mortar soon after its first exposure to the air by the advance of mining work.

MOLYBDENITE is used in the manufacture of ammonium molybdate, a chemical reagent employed in the laboratory in the determination of phosphorus in iron ore, the products of the iron furnace, and in fertilizers. The metal molybdenum is added to steel in order to make it self-hardening. From 5 to 10% of molybdenum raises the elasticity and tensile strength of steel, and gives it greater toughness. The tensile strength of molybdenum-steel wire is stated to be from 200,000 to 270,000 lb. per sq. in., that of tungsten-steel 480,000 to 580,000 lb. to the square inch.

Analysis of Molybdenum Ores

By H. Westling and Carl Andersen

The analysis of molybdenum ore presents several difficulties as yet not thoroughly discussed in the literature on the subject and we have been compelled to work out a method of our own which, so far as we have ascertained by actual practice on many ores from various parts of the country, is satisfactory.

For the purpose of our work with the U. S. Molybdenum Co., we found it necessary to have a method of analysis that would give a quick and accurate return, not only of the molybdenum but also of the constituents that usually accompany molybdenum. These are silicious residue, copper, iron, and not infrequently lead and bismuth.

Two difficulties had to be overcome if any reasonable degree of accuracy was to be reached. The first was the peculiar behavior of molybdenum to hydrogen sulphide in acid solution. We found that the one essential to complete precipitation of the metal was hexavalency. It seems, however, as if a small amount of molybdenum would be reduced to lower valency simultaneously with the precipitation of the greater part as MoS_3 . Especially will this happen if iron is present in the solution. Mellor recommends precipitation under pressure, but even this, although satisfactory in the absence of iron, is not quite complete in one operation when iron is present.

The second difficulty was the separation from copper. This seems impossible to effect when it is in the sulphide state. Pure sodium-sulphide solution will separate copper completely from the arsenic group of sulphides, to which molybdenum belongs. When we tried this, we found that copper misbehaves in this particular respect when molybdenum is present. After trying several methods we adopted the one below described. This has the advantage of effecting the separation at the very time of titration for molybdenum.

In the description of our method, we have made references to the general scheme of analysis used in the Rankin-Westling laboratory.

Our method is as follows: Dissolve 2 grams of the sample in 20 cc. HNO_3 , 20 cc. HCl , 20 cc. H_2O . After main action has ceased—usually after 10 to 15 minutes boiling—add about 20 cc. 60% H_2SO_4 , and evaporate to copious white fumes. Proceed in the usual way for lead sulphate and silicious residue.

The filtrate from lead sulphate and silica should now be boiled with a few crystals of ammonium persulphate (to oxidize a small quantity of lower valency Mo up to hexavalent Mo). Boil a few minutes to destroy persulphate, then cool, and precipitate with H_2S . After one hour of brisk current of H_2S in cold solution, discontinue the H_2S and boil the solution a few minutes. Then filter the H_2S precipitate. Wash with previously-boiled cold

water containing $\frac{1}{10}$ of H_2S water. Treat the filtrate as later described, and the precipitate as below:

Rinse the bulk of the precipitate into a beaker with water. Wash the filter-paper with dilute boiling aqua regia (1 part HNO_3 , 1 part HCl , 3 parts water). Run down into beaker with main precipitate and boil to dissolve same. When the precipitate is well dissolved, filter off the free sulphur, and evaporate to white fumes with about 5 cc. 60% H_2SO_4 .

Then cool, dilute to about 60 cc.; neutralize with $\frac{1}{2}$ NH_3 (1 part strong NH_3 , 1 part H_2O) until there is a distinct smell of NH_3 . Note if white or yellowish precipitate separates out. If so, filter and treat it for bismuth.

To the solution add enough acetic acid to smell natural, and 5 grams of sodium acetate, dissolve same, and titrate for MoO_3 with standard solution of lead acetate, using tannic acid as outside indicator. If the titration should go beyond the point, titrate back with the standard ammonium molybdate used for lead titration. When the titration point is accurately reached, allow to stand 10 minutes, then filter out the lead molybdate, wash once with cold water. Make the filtrate distinctly acid, using 5 cc. strong H_2SO_4 , then precipitate the copper with H_2S . Wash and treat as above described for copper.

The reason why ammonium persulphate is added, and then destroyed, before the introduction of hydrogen sulphide is as follows:

The molybdic acid is evaporated with H_2SO_4 , especially in the presence of free sulphur; a small part of the molybdic acid is reduced to compounds of lower valency, some of which precipitate very slowly, and some not at all, with H_2S in acid solution. Hence the persulphate. Farther, when molybdenum occurs in solution as molybdic acid in the presence of ferric iron, and hydrogen sulphide is introduced, there are several reactions happening simultaneously. When the solution is hot, the H_2S acts rapidly on the ferric iron, reducing it to ferrous iron, which again acts on molybdic acid, reducing the latter to lower-valency compounds which are not acted on by hydrogen sulphide in acid solution.

On the other hand, when the solution is cold, molybdic trisulphide precipitates before this reducing action takes place, hence the solution must be cold while Mo is precipitated. However, a small amount of molybdic sulphide is soluble in water containing H_2S , probably as colloidal sulpho-molybdic acid. Hence the boiling before final filtration.

The titration with lead acetate is slightly interfered with, when copper is present, because copper gives a green color with the tannic acid indicator. The yellow color of molybdic acid with this indicator, however, comes out first, and after a little practice there is no diffi-

culty in seeing the end point, when the yellow changes to green. The titration is best done at ordinary temperatures.

When the lead-acetate solution is made up, enough ammonium acetate must be added to make sure that no basic lead salts will precipitate on diluting the solution to proper strength. To make up lead solution, dissolve 18.35 gm. lead acetate crystals, $\text{Pb}(\text{C}_2\text{O}_2\text{H}_3)_2 + 3(\text{H}_2\text{O})$, in 100 cc. strong solution of ammonium acetate, and make up to one litre.

Sometimes the molybdenum is not completely precipitated with hydrogen sulphide, even when the above precautions are carefully followed. In that case, it will always be recovered when the iron is precipitated, as follows:

Boil the filtrate from the H_2S precipitation with a few crystals of ammonium persulphate, to oxidize both the iron and molybdenum possibly still present in the solution, then add ammonia (dilute enough to prevent spluttering) until the iron and alumina are precipitated, and a distinct excess of ammonia is left in the solution. Boil a few minutes, still maintaining excess of ammonia, then filter, and wash with hot water. Dissolve the precipitate in dilute H_2SO_4 and determine the iron either by zinc and permanganate titration, or by bichromate titration.

The filtrate from the iron precipitation may contain a residue of molybdic acid; it is now boiled, to remove excess ammonia, then cooled, and made acid with about 5 cc. of 60% H_2SO_4 . Add H_2S for half an hour, then remove the H_2S tube, and boil the solution. If any molybdenum is left in the solution, it will now precipitate completely. Filter, wash with previously-boiled cold water. Add precipitate to the rest of the molybdenum, or titrate separately, as before.

The solution may now be treated for manganese, zinc, lime, and other substances, as described in the general method of analysis.

It will be noticed, that the above-described procedure would be interfered with by the presence of a large percentage of copper as compared to the molybdenum. Arsenic and phosphorus in appreciable quantities also would interfere, by the formation of compounds with molybdic acid.

None of the objections, however, are of any importance in practice, because they do not occur in any of the molybdenum ores that we have analyzed so far. To be sure, we have seen ores containing arsenic, where a little ammonium arseno-molybdate was formed. It was filtered off, dissolved in a little ammonia, made acid with sulphuric acid, reduced with zinc, and titrated with permanganate.

So thorough has been the sanitation of the Panama Canal zone that the last case of yellow fever contracted there was in 1905. This is the more remarkable as prior to the improvement of conditions on the Isthmus of Panama, not a year passed when Yellow Jack did not flourish among the native population, and travelers were frequently among the victims, where this terrible disease is endemic.

California's Volcano Still Active

Mount Lassen, contrary to the expectation of some, continues to give repeated though irregular evidences of temper. After an interval of rest, extending over several weeks, it suddenly went into action on the afternoon of December 10, discharging a large quantity of comminuted material and rocks that quickly converted the dazzling whiteness of the snow-clad mountain to an ominous, sombre dark gray. This eruption, it is stated, was accompanied by very little water vapor.

Thus far, Lassen has afforded an exhibition of three types of eruption, the Vulcanian, the Peléean, and the Strombolian. In the vulcanian type the explosions are violent, ejecting much consolidated ancient lava, accompanied by dense clouds of smoke (dust) and water-vapor. In the Peléean type, the volcanic cloud is so heavily laden with solid materials that it, together with the water-vapor, after rising rapidly above the vent, driven upward by the explosive force within the volcano, falls rapidly by gravity and rolls down the mountain side in heavy clouds, as on the morning of June 14, 1914. Strombolian eruptions consist chiefly of finely comminuted rock, small fragments and angular boulders, some of them large, torn from the sides of the vent, but there is little water-vapor present. The eruption of December 10, was evidently of this latter type.

The mud streams that are reported to have flowed from the crater some time since may be due to either of two causes: first, the rapid condensation of water-vapor, producing a large amount of water which would quickly wash down the accumulated fine material lying on the slopes of the mountain, forming rills of mud, which, uniting lower down, become good-sized streams heavily-laden with the ejected finer products of the volcano. Second, the welling-up in the crater of a large amount of the fine rock material saturated with water, the presence of which is due to condensation of water-vapor on approaching the surface. If this mud is ejected in sufficient amount, it would flow down the slope of the mountain in streams, the size of which would depend upon the quantity of material poured out and the velocity with which it is ejected. This phase is distinctly that characteristic of the Taal volcano, thirty miles south of Manila, on the island of Luzon, which went into violent eruption in 1912, after a long period of quiescence.

It is impossible to predict what Mount Lassen may yet do in the way of eruption. It may continue spasmodic eruptions, such as have characterized it during the past two and a half years, and finally settle down to a staid and uneventful existence, or it may at any moment break into violent and devastating eruption, destroying a good part of the mountain mass, and spreading a thick blanket of volcanic ash over hundreds of square miles of the surrounding country, as did Katmai on the Alaska Peninsula in 1912. Only time will tell; meanwhile, it is an excellent place for the curious to avoid, pending events at Mount Lassen.

Minerals Separation Decision

In the Minerals Separation decision rendered on December 11, the Supreme Court held that seven of the company's claims on patents were valid where the amount of oil used was in the proportion of a fraction of 1% to the amount of ore. Three claims which did not specify the precise proportion, but merely specified the use of "a little oil," were held invalid. The rejection of these claims is held by the company's representatives to be inconsequential, while the affirmation by the Court of the validity of the practicable patents held by it is said by them to be immensely valuable. The Supreme Court's decision reversed the findings of the Circuit Court of Appeals for the 9th circuit, and affirms the decision of the District Court of Montana as modified as to the three inconsequential claims.

The patents adjudged as belonging to Minerals Separation cover the so-called froth flotation method of concentrating copper and sulphide ores. The process involved the violent agitation of the powdered ore, mixed with water, and a critical proportion, a fraction of 1% per amount of ore, of oil or oleic acid. The result achieved is that the fine particles of valuable minerals rise to the surface of the mixture whence they are readily floated off into receptacles, while the valueless residue sinks.

The Court says: "The decision of the Circuit Court of Appeals will be reversed, and the decision of District Court modified to conform to the conclusions expressed in this opinion, will be affirmed."

The decision reviews at some length the arguments of both sides and then says:

"The evidence of infringement is clear. While we thus find in favor of the validity of the patent, we can't agree with the District Court in regarding it valid as to all of the claims in suit. As we have pointed out in this opinion there were many investigators at work in this field to which the process in suit relates when the patentees came into it and it was while engaged in study of prior kindred processes that their discovery was made. While the evidence in the case makes it clear that they discovered the final step which 'turned failure into success,' yet the investigation proceedings were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony, and in the claims of the patent as 'critical proportions' amounting to a fraction of 1% on the ore, and therefore the decree of this Court will be that the patent is valid, as to claims numbered 1, 2, 3, 5, 6, 7, and 12 and that the defendant infringed these claims, but that it is invalid as to claims 9, 10, and 11. Claims numbered 4, 8, and 13 were not considered in the decrees of the two lower courts and are not in issue in this proceeding." The Court points out that all allegations in the bill are denied and that the defendant (Hyde) "a man obviously experienced in the subject, says that in his opinion the whole basis for flotation concentration was disclosed in the Everson United States patent and the Froment British patent. It is clear that in the prior art as it is developed in this record, it was well known that oil and oily substances had a selective affinity or attraction for and would unite mechanically with the minute particles of metal and metallic compounds found in crushed or powdered ores but would not so unite with the quartz or rocky metallic material called gangue. It was also well known that the selective property of oils and oily substances was increased when applied to some ores by the addition of a small amount of acid to the ore and water used in process of concentration."

Prior to the patent in suit a number of patents had been granted, the decision points out, all of which, broadly speaking, consisted in mixing finely crushed or powdered ore with water and oil. From the resulting concentrate the metals were recovered in various ways. The Court adds that processes of this general character could be roughly divided into two classes. The process of the first class is called the "sur-

face flotation process," which depends for its usefulness on the oil used being sufficient to collect and hold in mechanical suspension the small particles of metal and by its buoyancy to carry them to the surface of the mixture. The other class, called "metal-sinking process," reverses the action of the surface flotation process. The process of the patent in suit, the Court says, consists in the use of the amount of oil which is "critical" and minute as compared with the amount used in prior processes, "amounting to a fraction of 1% on the ore." After describing this process the decision says "it is obvious that the process in suit is not of the metal-sinking class and while it may in terms be described as a surface flotation process, yet it differs so essentially from all processes in its character, in its simplicity of operation, and in the resulting concentrate, that we are persuaded that it constitutes patentable discovery."

Continuing, the Court says: "The prior processes which we have described required the use of so much oil that they were too expensive to be used on lean ores, to which they were intended to have their chief application, and the efforts of investigators for several years prior to the discovery of the process in suit had been directed to the search for a means or method of reducing the amount of oil used, and it is clear from the record that approach was being made, slowly, but more and more nearly to the result which was reached by the patentees of the process in suit in March 1905."

The Court characterizes the Froment Great Britain patent as "little more than a laboratory experiment" which has never proved of value in practice, while of the Kirby United States patent it says, "though approaching in some respects more nearly to the end attained by the process of the patent in suit, found its preferred application in the use of an amount of oil solution equal to one-fourth to three-fourths in weight of the ore treated, which was prohibitive in cost." It was at this point, says the Court, that patentees came into the field in investigation. They worked on the Cattermole process as a basis when they discovered that "an increase in the amount of froth reached its maximum when about 1% or slightly less on the ore of oleic acid was used," this froth of air bubbles held in suspension between 70% and 80% of the total mineral content of the mass treated. "It was promptly recognized by the patentees that this froth," says the decision, "was not due to liberation of gas in the mass treated but rather to the presence of air introduced in the mixture by the agitation which had been resorted to to mix the oil with the particles of crushed ore, which air, in bubbles, attached itself to the mineral particles, slightly coated as they were with what was necessarily an infinitesimal amount of oil, floated them to the surface." The lifting force, the Court says, is in the buoyancy of the air bubbles caused by agitation. It results without more discussion, says the Court, "that we fully agree with the decision of the House of Lords" in other cases.

The claim that the patentees of the patent are not the original discoverers of the process patented because an employee of theirs happened to make the analysis cannot be allowed. Equally untenable is the claim that the patent is invalid for the reason that the evidence shows that when different ores are treated preliminary tests must be made to determine the amount of oil and extent of agitation necessary in order to obtain best results.

COPPER output of Mt. Lyell, Tasmania, during the half-year ended September 30, 1916, was 7,104,520 lb., also 4183 oz. of gold and 170,399 oz. of silver. The cost of mining was \$2.50, smelting and concentration, \$2.76, and converting 38c., a total of \$5.64 per ton. In the previous quarter the cost was \$4.56 per ton. The blast-furnaces reduced 151,836 tons of ore and flotation concentrate.

SULPHUR production from the pyrite of Mt. Lyell has been proved practicable. Several kinds of muffle-furnaces are under trial.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

WAGES RAISED.—ORE TREATMENT AT ROBINSON.

Local mine-owners have again raised the wage-scale. Employees who have been receiving \$3.30 per shift, including miners, shovelers, trammers, and top-men, were given a raise of 20c., making \$3.50. Timber-men, machine-men, and other skilled workers who were receiving \$3.85 receive 15c. extra, making \$4. Hoist engine-men, mechanics, and skilled men who had been paid at the rate of \$4.40 get 10c., making \$4.50 per shift. This new increase makes a uniform raise of 50c. a shift over and above the wage-schedule in force in the district prior to the 10% increase made last April. The new rate will continue in force until further notice, according to the statement issued to the men by the different companies here. It is not based on any market quotations, and is in no way dependent on future conditions. The announcement that the operators had decided to raise wages came as a surprise. It was generally thought that no steps would be taken in the matter until after the State Industrial Commission had investigated the wage situation and made some recommendation. Members of the Commission did not put in an appearance, although it is reported that they were securing information on local conditions. The delay on the part of the Commission caused the operators to get together and carefully consider the wage question. They came to the conclusion that under the existing conditions an increase was justified, and quietly informed their employees of the new schedule when issuing pay-checks on December 5. The increase dates from the 1st of the month. Leadville is now a \$3.50 district for miners. All the large producers have instituted the new schedule, including the Iron Silver Mining Co., Western Mining Co., Empire Zinc Co., Leadville Unit of the U. S. S. R. & E., Star Consolidated Mining Co., Yak Mining & Milling Co., Down Town Mines Co., Julia Mining Co., Dinero Mining Co., Valley Mining Co., Louisville Mine, the Bowden Leases, and others.

The Progress Mining & Milling Co. has just completed a unit of the Wilson mill at Robinson having a capacity of from 150 to 200 tons, using a new process that had been tried previously and proved a success by William B. Brooks, assistant manager. The company was first organized about four years ago by Mr. Brooks and others, and until the early part of this year work was confined to laboratory tests at Leadville, on the lead-zinc ores of the Leadville and Robinson districts. The first plans of the company after fully proving the success of the process, included the taking over of the old American Zinc company's mill near the portal of the Yak tunnel. This deal was not closed, and the attention of the company was turned to the old Wilson mill at Robinson, situated in the centre of one of the largest and richest lead-zinc areas of the State. The manager, Ross D. McCausland, and assistant manager, W. B. Brooks, entered the Robinson district in March, and purchased the Wilson mill and mining property of 26 patented claims. The work of overhauling the old plant and installing new machinery was commenced at once. In spite of numerous delays in delivery of equipment, rapid and satisfactory progress was made. The plant is capable of treating from 150 to 200 tons per day. It is equipped with a 1000-ton crushing-plant, the largest set of Traylor rolls in the State, Denver Engineering Works' ball-mills, Dewey roasters, Wilfley, Burchart, and Deister tables, and a K. & K. flotation machine, the last being delivered at the plant a few days ago. The trial runs that have

been made since the installation of the flotation machine prove the value of the process. After being crushed the ore is reduced to 40-mesh in the tube-mills. Tables concentrate out the lead, silica being discharged in the tailing. The zinc-iron middling is roasted in the Dewey machines, then separated by flotation. The process recovers 80% of the zinc in a concentrate containing at least 40% metal. The greater part of the gold-content remains in the iron; the lead contains the silver. The process will yield these products: lead concentrate carrying some gold and silver, zinc concentrate, and a low-grade iron concentrate containing most of the gold. The zinc and lead will be marketed separately, and the iron will be stored to be cyanided in the coming spring, when a plant will be erected for this purpose. Results from the second days' run showed the galena from the tables to assay 75% lead, and only 1% zinc. The zinc concentrate from the flotation machine assayed from 40% to 46% metal, with a trace of lead. These results prove beyond any doubt the efficiency of the process for the separation of Robinson ore, and may be looked upon with considerable satisfaction.

The Progress company controls a great supply of ore. At present, there are 800 tons of crushed ore in the mill-bins, and 30 railroad carloads on the siding at the plant. The company owns the Wilson property, has a lease and bond on the Robinson, Felicia Grace, and Champion, and has contracted for the output of the Michigan, Colonel Sellers, and surrounding mines. Engineers who recently inspected these mines, and those who made reports on them in the past, place the minimum milling ore available as 3,000,000 tons, and the maximum at nearly double that figure. The average value of the ore as determined by numerous samples taken from every vein, streak, and face of ore now open is \$20 per ton; many of the samples assayed above \$50 per ton. No ore under \$15 will be purchased by the company under contract.

The Robinson district is credited with a production of \$36,000,000, the old Robinson mine alone contributing \$6,000,000. At the time of this output, nothing but ore that had a gross value of \$100 per ton, or better, was mined, with the result that much of the ore remaining is of fair value. With the present high prices for lead and silver it is possible that a large tonnage will be mined of sufficient value to be shipped direct to the smelters without separation. The Progress company also proposes to do some deep mining in its territory. All of the ore that has so far been discovered in the district has been found in what is known as the Robinson contact, lying between the white sandstone and blue lime. The ore in this contact has been developed to a depth of 1200 ft. in the Wilson mine, but no work has been done below it. Diamond-drill holes put down from the old Robinson tunnel several years ago cut a strong sulphide shoot at a depth of 212 ft. below the tunnel-level. The ore gave fair value in gold. The formations that have proved so productive in the Leadville district underlie the deepest workings in the Robinson area. These will be penetrated during the coming summer by several drill-holes to be put down from the lowest level of the Wilson mine.

Officers of the company are: Philip S. Smith, president; Ross D. McCausland, vice-president and manager; William B. Brooks, assistant manager; and M. E. Peters, secretary. The first three named, with R. W. McCausland and Martin Barber, form the board of directors. The main offices of the company are at 926 Equitable building, Denver.

JOPLIN, MISSOURI

A SURVEY OF THE MISSOURI-KANSAS-OKLAHOMA REGION.

Increasing zinc-ore prices during the past two months have brought this district out of its summer dullness to activity not exceeded heretofore, with the possible exception of June, 1915, when ore sold for \$137.50 per ton, basis of 60% metal-content. In September the average basis price of zinc concentrate was \$55.62; in October, \$65.56; and in November, \$86.25. As a result of these substantial advances, many properties that were shut-down during the summer have been started once more. The immediate prospect is unusual activity all winter.

The only serious trouble is the power question. Low water due to the drought, resulting in bad water, caused boiler trouble at the Empire District Electric Co.'s Riverton plant. Added to this, the company's three large turbo-generators have burned out, one after another, and during the past week the breaking-down of the last engine necessitated an order from the company prohibiting the use of electric current at the mines for anything except pumping. It is estimated that this means a curtailment of at least 20% of the district's production, some of the larger properties affected being the Picher mills at Picher, Oklahoma, the A. W. C. mines at Joplin, and the American Z. L. & S. Co.'s Klondike mill at Granby. These use electricity exclusively, and besides these there are many other smaller properties so equipped with motors. Many operators would use steam or gas, but they have no assurance of being able to get gas, and coal-dealers are refusing to supply new heavy consumers, declaring it is all they can do to take care of their present customers. In the meantime the power company is sparing no expense to get running once more, spending not less than \$300,000 in order to make certain that similar trouble will not occur again.

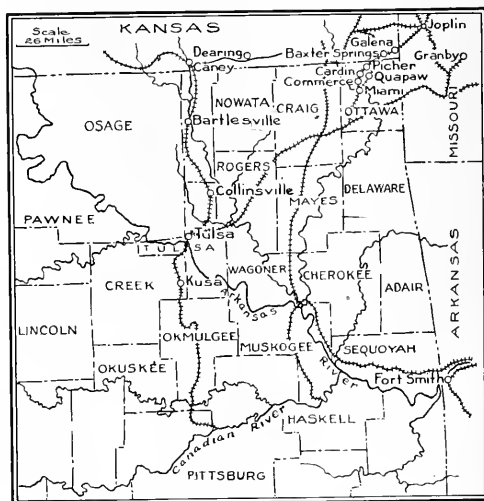
Notwithstanding the power shortage, the output of the district is greater than ever, the continued extraordinary developments in the Oklahoma field being principally responsible. During the past week the 'turn-in' from the Miami district was in excess of 2000 tons of blende, and there is every reason to believe that it will be close to this every week from now on, and may even exceed it. Most of the development is in the vicinity of Picher, Cardin, and Century, the new centres that have sprung-up, mushroom-like, in the past 18 months, on the level prairie $\frac{1}{2}$ miles north of Commerce. At Picher, the Eagle-Picher Lead Co.'s four mills are making regular turn-ins. The Netta, the last of these mills to be erected, is one of the largest in the district, having a capacity of 1200 tons in 24 hours.

At Century, the Montreal Mining Co. has just completed the construction of a new mill, and is regularly in the turn-in list. This property was the richest hand-jig mine ever opened here, and promises to be almost as much a record-breaker as a milling property.—The Lucky Kid also is operating regularly now, with large production.—The Welsh Mining Co. has just completed a new 400-ton concentrating plant that will add to the output. This company is backed by the Church-Mabon interests that developed the ground at this point. It was rich almost from the first drill-hole, but is expensive in pumping. The pumps now at work include a Pomona with a capacity of 4000 gal. per minute, a 10-in. Texas centrifugal pump, and a smaller Pomona, besides a number of air-lift pumps. It is asserted that the Church-Mabon interests have expended not less than \$50,000 for pumping alone.

At Cardin, the Blue Goose and Beaver mines continue to be heavy producers. A new company has taken hold of the Cornfield, and will start it during the coming week, working on a newly-discovered deposit of the north-east part of the lease.—Construction of two new mills has been started by the Commerce Mining & Royalty Co., owners of the Beaver and Blue Goose, one to be known as the Blue Jay. The U. S. Smelting Co. has just completed the re-construction of the old Ravens-

wood mill, which it moved from Reeds, Missouri, on a 60-acre lease not far from the Blue Goose.—The Walker Mining Co. has started working its new mill.—The Underwriters new mill is yielding concentrate at the rate of more than 100 tons per week.—The Admiralty Zinc Co. now has three mills operating.—Numerous other companies are at work, drilling or preparing to start new mills.

In the Webb City-Carterville district of Missouri, the most important addition to the producers is the Red Bird Mining Co.'s plant, owned by Tulsa, Oklahoma, parties already largely interested in this field, and situated on the site of the old En-



THE ZINC-LEAD DISTRICT OF OKLAHOMA.

deavor mine, just south of the American Z. L. & S. Co.'s group. This plant started a few weeks ago and is producing 60 tons of blende and a similar amount of lead each week, and yet is operating the mine and mill only one shift. This also excludes the sludge output, which averages $4\frac{1}{2}$ tons daily. The sludge-plant consists of 12 tables, with three more to be added this week, a Henry screen for sizing, and a 40-ft. Dorr thickener. The sludge-plant is operated by electric motor, but the remainder of the plant by steam, there being three 150-hp. forced-draught boilers, an innovation for this district. It is expected that the present output will be doubled when two shifts are employed, in the near future.

As previously mentioned, the output from Joplin has been greatly reduced during the past 6 weeks by shortage of water and electricity. The A. W. C. mines west of the city, with four motor-driven concentrating plants, have been able to operate only half-time, so far as power was concerned, and could not work even this much most of the time on account of the water. The company also had a surplus of 1000 tons of blende in its bins, and it is believed this had something to do with a several weeks' shut-down, which is now at an end. The blende, which the company willingly had sold at one time for \$75 per ton was sold a week ago at \$95 basis. The plants are in operation again.

At Duenweg the new plant of the Coahuila Mining Co. has been the biggest producer, and continues such. The company this week started up its No. 1 mill once more, after a shut-down since early in September; and also its No. 2 plant at Carthage, formerly the Hermosa.—At Duenweg the Evans-Hall-Soy mine, once known as the Rosebud, after a modest beginning following the completion of its new concentrating plant, has developed into a consistently heavy producer, with fine pros-

pects.—The Wampler interests have just got a shaft into ore on a lease south-west of the town, and hope to have a profitable mine in virgin ground. If they are successful it will mean the extension of the Duenweg field to the south-west a half-mile or more. The formation is similar to that found at the Baltic and Wilson mines.

Production at Granby, while handicapped so far as the largest plant was concerned, (the Klondike, which is electrically equipped), has been making big turn-ins during the past few weeks, particularly of silicate. To a large extent it is ore that was hand-cobbed during the summer, and held for higher prices.

On the whole, the immediate prospects for the Missouri-Kansas-Oklahoma region are very satisfactory. The large surplus of zinc concentrate that was on hand two months ago has not entirely disappeared, but so nearly that little is heard of it as a bearish tendency on the market. It is expected that the shortage in electric power will be entirely eliminated by the first of the year, and while cold weather will affect production somewhat, there is reason to believe that the year will end with the weekly output from the mines heavier than ever before in the history of the district.

PLATTEVILLE, WISCONSIN

SATISFACTORY CONDITIONS IN THE ZINC, LEAD, AND PYRITE BUSINESS DURING NOVEMBER.

Wisconsin zinc and lead miners enjoyed an unusually prosperous period during November. Remarkable advances were made in the prices of all mineral products offered for sale; weather conditions were ideal, allowing uninterrupted operations and perfect roads for teaming; tension in the labor demand, which was acute at the beginning of the month was lessened but not entirely relieved; and power furnished by the principal generating plants supplying the entire field was constant, and acknowledged to be fair by leading operators. With this combination of advantages it was surmised there would be a stimulated recovery of ore extracted, but it did nothing of the kind, and no deep search was required to ascertain the reason. As prices, especially for zinc ore, rose from day to day, miners prudently calculated that it would both pay to hold ore ready for shipment and conserve ore underground. In this they again proved their business acumen, and for a time while prices were soaring shipments of high-grade zinc ore from refining plants to smelter were significantly light. The beginning of November found blende in ordinary demand at \$70 per ton, base of 60% zinc-content. Medium and second grades held at \$5 per ton less, the range including ore assaying as low as 50% metal. Under this last figure all grades were designated as low, and many independent producers actually went begging for a market. This condition was of brief duration; immediately the spelter market displayed bullish tendencies, the price of zinc ore began to climb, and all grades of zinc ore were in active demand.

The reserve of ore in the field at the close of October, and conservatively estimated at 2000 tons, was soon eliminated, one quick deal for 1000 tons being closed in the Linden district, and the Eagle-Picher company cleaned-up the remainder in both the Midlin and Dodgeville districts. Toward the close of November there was almost a complete reversal of ideas on low-grade ore, which was being bid-in on a basis of \$1.20 per unit of zinc-content. Whereas at the beginning of the month some producers had been seeking a market, at the close a genuine scarcity of low-grade products to keep reduction plants running full time had manifested itself, and sharp competition developed among buyers to cover this class of ore offered in open market to the highest bidder. During this state of affairs the New Jersey Zinc Co. was exceedingly active, in numerous instances over-bidding its nearest competitor several dollars per ton; in this manner it managed to obtain

most of the low-grade ore offered, and shipments of high-grade refinery material from its separating plants at Mineral Point exceeded 6,000,000 lb. The Eagle-Picher Lead Co. was also active in its quest for high-grade zinc ore, and secured a fair quantity. The Grasselli Chemical Co. of Cleveland, Ohio, became the runner-up for the field on buying, following closely on the heels of the New Jersey Zinc Co., and through contract arrangements cutting-in on several of the old-established buying-agents here. The Wisconsin Roasters and the National Separators treated large quantities of low-grade ore, and shipments of finished product became heavier toward the end of the month.

The close of November found miners exceedingly affluent, and in good humor for Thanksgiving Day. Zinc ore had reached the \$100 mark for premium grades, and the base held strong at \$98 per ton for 60% blende. All other grades were in good demand, and producers displayed a uniform tendency to withhold shipments. Whether this followed a concerted agreement or otherwise is not known, but the situation was quite apparent to the close observer.

In other ways November contributed material gains to a still higher stage in physical development of the local field. Newly-developed mines, with complete modern equipment, were introduced for the first time in the Linden, Midlin, Platteville, Benton, and New Diggings districts. Official announcement was made by the Wisconsin Zinc Co. that early in 1917, three new power and mining plants would be constructed in the Benton district. A mill was being built at the Champion mine at New Diggings during November, the purpose of which is to wash out all lime compounds from the finished refinery ore, a contamination for which refiners are at present suffering severe penalties. Several classifiers and eight slime-tables were being installed. In addition to the improvement made by the building of the wet mill a great warehouse was being erected where supplies of all kinds for the mines, mills, refineries, and boarding-houses of the Wisconsin Zinc Co. will be stored. Drilling operations continued effectively in the southern districts, and several new mining companies were organized.

Proportionate gains were registered in the price of lead ore, zinc carbonate ore—of which a small quantity was marketed during November, and iron pyrite. Lead ore was in fair demand at the beginning of the month on a basis of \$80 per ton, the price advancing steadily until \$91 had been reached. Even with this inducement at hand a small tonnage cleared, producers scenting higher prices and withholding shipments.

Carbonate ore, quotations for which are governed by calamine quotations of the Joplin field, Missouri, made substantial advances, going from \$40 to \$65 per ton, basis of 40% zinc-content. Wisconsin miners were at the mercy of such buying as was offered by outside interests, fair-grade ore selling on a basis of \$30 per ton, at which price a small tonnage cleared, the bulk of the ore held being carried over.

Iron pyrite that has been coming from the reduction plants exclusively, and mainly under contract arrangement, showed increases in price, the average being \$4 to \$5 per ton at the beginning of the month. Offers of \$10 per ton were revealed in certain quarters, but shippers tied-up under contract failed to share in the improved prices. Crude iron pyrite, in the hands of independent producers, was not to be had, as mines capable of producing in quantity had long been abandoned because of the unsatisfactory state of the market all the year, so there was no one so situated in this respect that might take advantage of the increase in price. An attempt to raise crude pyrite was being made to meet the better market.

Deliveries of ore from the 1st to 25th were 44,376,000 lb. zinc, 722,000 lb. lead, and 5,586,000 lb. of pyrite. The gross recovery of crude ore totaled 37,000,000 lb.; net refinery ore to smelter direct and mine run under contract to Grasselli Chemical Co. 24,000,000 lb. There was 2000 tons of reserve ore in the field, all grades, at the end of the month.

SUTTER CREEK, CALIFORNIA

OLD EUREKA, KEYSTONE, CENTRAL EUREKA, AND SOUTH EUREKA.

The shaft at the Old Eureka mine has been unwatered and re-timbered to a depth of 1150 ft. from the surface. The shaft appears to be in good condition as the water recedes, and no caves have been encountered since passing the 800-ft. station. With the exception of a few charred timbers found near 500 ft., no evidence has so far been found of the fire that is said to have caused the closing of the property years ago, so the damage done by that fire must have been confined to other shafts of the property. Men are engaged this week installing the new engine, and in building up around the collar of the shaft to bring it to the level of the new hoist. The construction of a large change-house for the miners will be commenced as soon as the necessary lumber arrives.

The heavy rain here during the early part of last week caused a small landslide on the hillside behind the new hoist building in course of construction at the Old Eureka mine, and some damage was done to the foundations being laid there for machinery. A small retaining wall will prevent trouble of this kind in the future. The shaft has been unwatered to a point just below the 1200-ft. station, and good headway is also being made in raising and filling in around the shaft-collar.

The Old Eureka shaft has now been cleared and re-timbered to a depth of 1225 ft., some delay having been caused by catching up a small cave at the 800-ft. station and in handling increased water. From 50,000 to 60,000 ft. of square timbers monthly is being used in the shaft. The dirt road leading from the county highway across the gulch to the mine is being reinforced with broken greenstone, several men and teams being engaged at this improvement. John R. Cahill of San Francisco has the contract for the erection of the new head-frame and ore-bins. This structure is gradually taking shape, as the immense timbers are being bolted into place above the 36-ft. concrete piers. Two of the hoist-drums have been put into place in the new engine-room built east of the shaft, and foundations for the engine are ready, so that the engine could be ready for operation within a few days were it not for the delay in arrival of electric equipment. Factories are so far behind with their orders that motors ordered last February for this plant have not yet been delivered, and it seems likely that there will be still further delay. The new hoist will have a lifting capacity of 15,000 lb. from a depth of 3300 ft., 1200 ft. below the present bottom of the mine. The Old Eureka hoisting plant is of similar construction to that recently installed at the Plymouth Consolidated Mines, although the latter is designed for a 5000-ft. haul.

The Keystone mine is to resume regular mining operations about the 15th of this month, by which time the shaft repair-work started during the strike will be completed. The shaft has been re-timbered to a point 400 ft. from the surface with timbers 18 by 18 in., and 18 ft. in length. The shaft-stations have also been enlarged and improved, concrete floors having been laid and modern appliances installed for handling supplies and ore. The company is also paying particular attention to sanitation and taking every possible precaution to safeguard the lives of its employees. C. R. Downs of Sutter Creek is superintendent, and B. I. Hoxsie is the foreman.

After two weeks' hauling by means of a large truck, all the machinery, buildings, and equipment of every description have been transferred from the Amador Queen mine south of Jackson to the North Star shaft of the South Keystone group. All possible speed is being made in getting the plant installed at its new site. Owing to the small amount of water in this shaft, only a short time need elapse before driving and cross-cutting can be started at the 600-ft. level to prospect the several claims of this consolidation. John A. McIntire of Sacramento, who is largely interested in this property, was a Sutter Creek visitor last week.

A cross-cut driven 640 ft. west from the 1800-ft. station of the Central Eureka mine has cut some good-looking quartz within the past few days. While low grade at the point of intersection, drifts will be run north and south on the vein, which appears strong and of good width. In the hope of insuring more rapid progress in sinking the shaft, the management contemplates having the men do the work on contract. The progress made since sinking commenced has not been up to expectations so far, and it is imperative that the shaft be sunk and new levels opened with the least expense, as the mine is being operated on assessments. The vein just encountered in the west ground is an encouraging feature, for it was in cross-cutting to the west in the adjoining South Eureka ground that the rich orebodies were developed several years ago, just in time to save that mine from closing down after a long period of assessments. The president, V. S. Walsh, and J. Toplitz, one of the directors, visited the property during the past week. Fred Jost is superintendent and W. J. Bryant foreman.

Contracts have been let for sinking the Central Eureka shaft at the rate of \$21 per foot, the company furnishing engineers, all tools, and supplies, except powder. Better progress has been made during the past week, the shaft having reached a point about 100 ft. below the 3200-ft. level. It is expected that sufficient ore will be developed by opening two new levels below 3200 ft. to keep the mine in successful operation for many years.

An encouraging development was made at the Oneida mine, part of the South Eureka company's holdings, during the week, a lode of good milling grade, varying in width from 5 to 15 ft., having been opened for a length of 109 ft. on the 2600-ft. level. The orebody so far gives every indication of persistence, and its discovery at this depth is particularly pleasing in view of the fact that the ore heretofore encountered in the lower levels of this mine has proved of low value. The Oneida was at one time equipped with a 60-stamp mill, and the grade of ore mined in the upper levels gave promise of a great future for the property, but the lower-grade material found at depth discouraged the owners, who ceased operations, disposed of their milling equipment, and finally sold their holdings to the South Eureka company. A cross-cut was driven on the 1800-ft. level to connect the two shafts, and for a long time the shaft below this connection was not unwatered. Sufficient ore was mined above 1500 ft. to keep 20 stamps in operation for a few months prior to the strike, but if this recent discovery proves as valuable as expected, the mill capacity will doubtless shortly be increased.

The orebody discovered recently on the lowest level of the Oneida mine is widening as work progresses, and still retains its value. For the first 100 ft. or so of driving the vein varied in width from 5 to 15 ft.; it has now been driven on for about 200 ft. and measures 30 ft. across the face. The old ore-bin at the shaft-collar has been repaired, and a new bin and waste chutes are now in course of construction. Twenty stamps are dropping constantly.

L. R. Poundstone of Colusa was a Sutter Creek visitor last week on business connected with the Rose mine, which is east of Sutter Creek. An engineer and pump-man are keeping the main shaft on the hill unwatered, and it is understood that negotiations are pending for a change of ownership and a resumption of operations. The present plant consists of a 20-stamp mill, small hoist, and compressor; and there are two shafts in good condition.

A few men are employed unwatering and repairing the Hardenburg shaft near the Mokelumne river, south of Jackson. The mine has been idle for three years and the condition of the shaft is such that only a few men can be worked to advantage at present; but a new pumping plant is being installed, which will result in better progress. Other improvements are being made, the surface plant receiving a thorough overhauling.

THE MINING SUMMARY

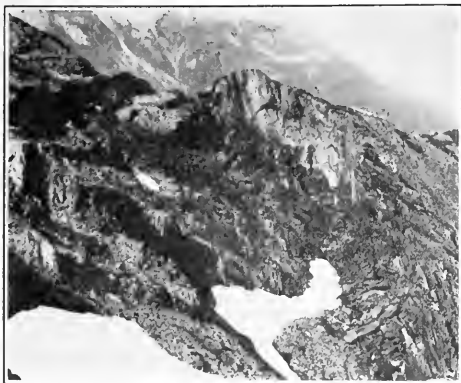
The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JUNEAU. The November yield of the Alaska Gastineau was 167,600 tons of ore assaying \$1.13 per ton. Compared with October there was an increase of 9600 tons, but a decrease of 19c. per ton in value. The recovery was 81.71%.

The suit of the Ebner v. the Alaska-Juneau company concerning water-rights on Gold creek is still before the Court at San Francisco, and a decision will not be given until next May.

Appropriations submitted to Congress include \$100,000 for



AT THE ALASKA GASTINEAU PROPERTY, JUNEAU.

a bridge across Gastineau channel from Juneau to Douglas island.

ARIZONA

GLOBE. A large deposit of high-grade manganese is being developed east of the Big Johnnie claims of the Old Dominion company, and adjoining the Iron Cap mine. Wright & Buckingham are lessees. Thirteen carloads have been sent to Chicago. A company has been formed to extend operations.

On the 800-ft. level of the Iron Cap mine the Arizona Commercial vein was cut last week showing 5 ft. of hornite.

MAYER. This district of Yavapai county is reported to be very busy. There are 250 men at the Blue Bell, 150 at the Stoddard, 150 at the Henrietta, 100 at the De Soto, and 100 at the Butternut. The new 100-ton smelter of the Great Western Smelting Co. was blown-in last week. The Big Lodge and other mines will supply the ore. The plant was partly made from material at the old United Verde smelter at Jerome. A. C. Cole is superintendent.

MIAMI. The Greater Miami Copper Co.'s manager, H. C. Malloy, has made a report on the property. Two large fissures have been opened considerably by shallow shafts and adits. From one vein a good deal of ore has been mined and treated locally in a crude way. Later development opened high-grade copper-gold-silver ore. Some rich silver ore is to be sent to the Selby smelter. No. 2 adit, started on ore containing 35 to 12% zinc, opened sulphides at a depth of 75 ft., the zinc disappearing, copper ore taking its place. So far the adit is in 84 ft. in similar material. A road 2 miles is to be constructed, costing \$1000. A mill is proposed.

CALIFORNIA

GEORGETOWN. The old Woodside mine is to be unwatered by R. H. Shannon.

OROVILLE. In the Banner mine operated by Richard Phillips ore assaying \$25 per ton has been opened on the 400-ft. level. The vein is 4 ft. wide and is getting wider. Twenty-five men are employed. Ten stamps are to start crushing. A transmission-line four miles long is being erected.

REDDING. Effective from December 1, employees (200) of the Balaklala Copper Co. at Coram will receive an increase of 25c. per shift; at Kennett the Mammoth Copper Co. is to pay its 1100 men a similar advance; and at Keswick the Mountain Copper Co. will do likewise to its 600 employees. The lowest wage in the copper belt is \$3.25 per day.

SONORA. Diamond-drilling, and exploration at 1300 and 1800 ft. constitutes some of the work being done at the Black Oak mine.

TAYLORSVILLE. Labor troubles are reported from the Engels copper mine in Lights canyon, caused, it is alleged, by I. W. W. agitators. Demanding an increase of wages from \$4 to \$5 per day, 200 men walked out, after which the company closed the property, putting 400 out of work. There was some fighting, but this was quelled by the Sheriff. The strikers said that men at the Walker copper mine, near Colfax, were getting \$5 per shift.

COLORADO

BOULDER. A new 150-ton tungsten mill, using tables and oil flotation apparatus, was started by the Gold Hill Concentrating Co. on the Slide dump last week. The plant is backed by G. W. Teal, C. A. Barr, R. R. Kermack, and C. Gustafson.

CRIPPLE CREEK. An extra dividend of 2c. a share was paid by the Portland on December 18. This equals \$60,000, and makes \$420,000 for 1916.

Eighty tons of ore from the Shoo Fly mine on Womack hill was valued at \$4000.

The Carolina company has taken over the Ajax mine. The three-compartment shaft is to be deepened from 1450 ft. to water-level, probably between 1300 and 2000 ft. The upper levels are to be explored.

The properties of the Granite Gold Mining Co. on Battle mountain are producing more than 100 tons per day of better than average grade ore. Development on company account is confined chiefly to the 1400 and 1600-ft. levels of the Dillon shaft.

A new company, the Modoc Consolidated Mines Co., has recently been formed to operate the Modoc mine situated in the saddle between Battle mountain and Bull hill. Among other proposed work the company intends to sink a vertical shaft to a depth of 1500 ft. to replace the old inclined shaft. The Modoc mine adjoins the Portland estate, and so far has produced \$2,000,000. A. H. Frankenberg of Pueblo is general manager.

It is expected that work will be resumed in the heading of the Roosevelt drainage-tunnel about December 10. Re-timbering of the Elkton shaft from the surface to the 200-ft. level necessitated a cessation of work in the tunnel. The heading was advanced 295 ft. during 17 days of November on which work was in progress, and is now 2100 ft. east of the Elkton shaft. At the last time measurements were taken the flow of water from the portal was 9500 gal. per minute.

On December 10, the Cresson Consolidated paid a 25% dividend; in addition to the regular monthly dividend of 10%, an extra dividend of 15% was distributed. It is reported that the extra payment will be made from the returns on three carloads of ore netting over \$60,000 per car. At a recent meeting of the newly-elected directors of the company, A. E. Carlton was re-elected president.

TELLURIDE. During November the Tomboy company treated 12,000 tons of ore yielding \$96,500. The profit was \$28,500.

IDAHO

According to Robert N. Bell, State inspector of mines, the lead and silver output of Idaho this year will about equal that of 1915, but the selling value is much higher. Zinc production will be much greater. The dividend total will exceed any previous year.

GILMORE. The Pittsburg-Idaho company paid 6c. per share on the 8th. This makes \$100,000 for the year. The reserve fund is \$100,000; and all debts have been paid. The mine is in good condition, and 190 men are employed.

KELLOGG. To supply its new smelter with limestone the Bunker Hill & Sullivan company has leased the old Evolution mine near Osburn. The rock contains a little lead, zinc, copper, silver, and gold, and 37.5% CaO. The owner of the property is to receive payment for 25% of the metal-content of the rock. The mine has an interesting history, being the first quartz location in the Coeur d'Alene.

PINE CREEK DISTRICT. The Kellogg United Mines Co., capitalized for 2,000,000 shares at 25c. each, has been organized by Spokane and Coeur d'Alene men to take over and operate three groups of claims in this district. The incorporators are Samuel A. McCoy, J. A. McEachran, George H. Wilson, and G. W. Sommer, all of Spokane, and Theodore Brown of Kellogg.

MICHIGAN

HOUGHTON. On January 1 about 17,000 men will participate in the bonus distribution of 25c. for each day for every employee who worked steadily from July 1 to December 31. There are now 25,000 men employed at the copper mines.

MISSOURI

JEFFERSON CITY. During the year ended June 30, 1916, two plants in Newton county produced 6300 tons of tripoli worth \$65,767. This is used as an abrasive and for filtering.

JOPLIN. The electric-power situation was improved last week by the Empire District company starting a 19,000-hp. turbo-generator. This will supply 60% of the district's normal demand, and will suffice underground work on day and mills on night shift. A number of mines thereby resumed work. A new 17,000-hp. generator is expected to arrive at an early date from the General Electric Company.

Ore prices were \$5 per ton weaker last week, due to a lower spelter market. The output of the Missouri-Kansas-Oklahoma region was 10,132 tons of blende, 293 tons of calamine, and 1250 tons of lead, averaging \$94, \$54, and \$91 per ton, respectively. The total value was \$1,071,434, and \$32,515,132 for 49 weeks.

MONTANA

BUTTE. During November Butte & Superior produced 14,300 tons of concentrate assaying 53% zinc from 53,880 tons of ore. The recovery was 93.7%.

To arrange for a spur-line for the eastern part of the district the Tuolumne and Bullwhacker companies have conferred with the Great Northern Railroad.

The Butte-Detroit company has started the Ophir concentrator on zinc ore from the Davis-Daly. The present capacity is from 150 to 200 tons per day, which is to be increased. This is the third zinc mill at Butte, including the Butte & Superior and Ehn Orlu.

ELKHORN. The East Butte Mining Co. should have its mill running early in 1917. Its capacity is 300 tons per day. The main shaft is being sunk another 100 ft.—The Rothfuss & Dickman mill is operating with good results.—The Elkhorn Queen is shipping regularly, and has a large quantity of ore available.

MARYSVILLE. During November the Barnes-King Development Co.'s bullion yield was \$80,024 from 7531 tons of ore. The Shannon mine contributed 3093 tons of \$15.80 ore.

NEVADA

ELY. Another 500-ton unit is to be erected at the Giroux mill of the Consolidated Copper Mines Co. The first unit is expected to start work early in January.

GOLDFIELD. At a depth of 840 ft., and 800 ft. north of the main station, the Reorganized Kewanas has opened \$45 to \$67 ore. Work is conducted through the Laguna shaft of the Goldfield Consolidated.

GOOSESPRINGS. The Contact, Copper Metal, and New Dominion groups of claims have been acquired by C. B. Stewart and others of Salt Lake City.

A shipment of copper-platinum ore from the Boss mine has just been treated at the Garfield smelter. The last carload was settled for \$6000.

LUNING. This district is as active as ever, producing between 2000 and 3000 tons of ore monthly. Most of the ore is a carbonate. The deepest shaft is 450 feet.

PICQUE. Results at the Consolidated Nevada-Utah mill are better than expected, the capacity being 10% greater. The ore treated contains zinc and silver. The heating system is a success. A heavy flow of water was encountered on No. 14 level.

THOMPSON. When the Mason Valley company resumes smelting here, it will have a large supply of ore at its own mine, and at the Bluestone mine in charge of C. D. Kaeding.

UTAH

Dividends paid by Utah companies during 1916 are as follows, according to the *Herald-Republican* of Salt Lake City:

	Per share	Amount	To date
Cardiff	\$0.75	\$ 375,000	\$ 500,000
Centennial-Eureka	1.00	100,000	4,000,000
Chief Consolidated	0.20	176,000	527,000
Eagle & Blue Bell	0.05	45,000	492,600
Eureka Hill	1.00	10,000	10,000
Gemini	16.00	80,000	2,435,000
Grand Central	0.04	20,000	1,634,750
Iron Blossom	0.35	350,000	2,850,000
Horn Silver	0.05	20,000	5,662,000
Judge Smelting	1.00	135,000	1,590,000
Lakeview Mining	0.10	65,000	124,000
May Day	0.07	56,000	300,000
Mammoth	0.25	100,000	2,420,000
Pacific Gold	0.02	8,000	8,000
Silver King Coalition	0.60	750,000	14,705,000
Silver King Con.	0.45	286,875	1,229,240
South Hecla	0.15	39,525	39,525
Utah Consolidated	3.75	1,125,000	11,434,000
Utah Apex	0.75	396,150	521,200
Utah Metal & Tunnel ..	0.50	342,470	1,243,470
Utah Copper	12.00	19,494,110	52,161,110
Total		\$24,374,430	\$103,886,895

The total in 1915 was \$10,025,000. Most of the increase was due to the Utah Copper Co., which paid under \$7,000,000 in 1915.

BINGHAM. The flotation plant at the Utah Metal company's mill is to be enlarged, giving a daily capacity of 300 tons, an increase of 75 tons.

The Utah Copper Co. of Utah has taken over the Ohio Copper Mining Co., paying all debts and liabilities of the latter company, which were over \$1,500,000.

GARFIELD. In the Arthur mill of the Utah Copper Co. improvements are under way in the fine-grinding department. More concentrators will be needed to care for this material. The company has 6000 acres for impounding tailing, around which a levee is to be built as it fills.

TINTIC. On December 9 the Gemini company paid \$6 per share, equal to \$30,000. This year's total is \$80,000, and \$2,435,000 to date.

The Tintic Milling Co.'s plant is treating 200 tons daily.

Two shifts at the Utah Ore Sampling Co.'s plant are passing through 600 tons of ore per day.

At the Tintic milling plant the seven roasting-furnaces are treating 200 tons of ore daily. The extraction is highly satisfactory.

On the 28th the Eagle & Blue Bell pays 5c. per share, equal to \$45,000. The total for this year is \$90,000.

The Grand Central pays 4c. on the 23rd, equal to \$20,000.

It is considered that Utah lake, 15 miles from Tintic, is the source of the water trouble in Tintic mines, and its drainage is now being discussed. At a depth of 2018 ft. the Eagle & Blue Bell mine cut a large flow of water, suspending sinking operations. At 1790 ft. the Chief Consolidated encountered water, and at 2310 ft. the Grand Central.

CANADA

BRITISH COLUMBIA

SILVERTON. Dividends are to be paid quarterly, instead of monthly, by the Standard Silver-Lead company. A loss of \$1111 was made in October, against a profit of \$17,785 in September, \$137,637 in March, \$88,008 in April, and \$40,968 in May. No zinc concentrate was shipped in October, but 3000 tons worth \$39 per ton net are now on the way to smelters. The surplus is \$202,669.

ONTARIO

COBALT. From the treatment of 162 tons of high and 6462 tons of low-grade ores, the Nipissing produced silver valued at \$246,630. The refinery shipped 490,782 oz. of bullion, partly from custom treatment. Development on No. 490 vein was satisfactory during November.

PORCUPINE. Gold production of the Dome Mines Co. in November was \$177,000 from 37,500 tons of ore. The cost was \$2.88 per ton.

KOREA

The Seoul Mining Co., operating the Suan concession in Whanghai province, Chosen, reports the following results for November: total recovery, \$141,750. In the Tul Mi Chung mine, developments in several workings are very promising. A favorable showing was made in several of the prospects being developed, the most important being an orebody 10 ft. wide, averaging \$9.50 gold per ton.

During October the Oriental Consolidated produced bullion worth \$123,836 from 26,391 tons of ore. The September rainfall was low, and this season's rain will not fill the Chorrre reservoir. Okura & Co. is to supply power at 1.5c. per kw.-hr., a reduction of a half cent. Cholera has killed hundreds of people in Japan, and the disease entered Korea late in September, but there have been no serious cases north of Seoul and Chemulpo.

THE STATE SCHOOL OF MINES, University of Utah, at Salt Lake City, is to have a course for prospectors from January 8 to February 3, 1917. Robert S. Lewis, of the department of mining, says that the work is in the nature of an experiment, and changes will be made to suit the needs of those who register for the course, should there be a real demand for such instruction. The subjects include geology and mineralogy, mining and milling, metallurgy, and laboratory work. There are no fees, save \$1 for registration.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

J. R. FINLAY has returned to New York from Arizona.

J. W. BRYANT is serving with the Royal Engineers in France.

R. H. CHANNING was here last week, on his way from Los Angeles to New York.

K. C. LI passed through San Francisco on his way from Shanghai to New York.

L. A. SMITH has been appointed inspector of mines for the Federated Malay States.

CHESTER F. LEE, of Seattle, has been examining mines in Butte county, California.

HERBERT W. GEPP, manager for the Amalgamated Zinc Co., has returned to Broken Hill.

C. H. BANKS has recovered from wounds received while with the Tunneling Corps in France.

D. D. HOMER, assistant general manager of Butters Divisadero, San Salvador, is in San Francisco.

W. S. BLACK has been appointed manager of the Ajax mine, at Cripple Creek, for the Carolina company.

E. H. C. OLIPHANT, editor of the *Australian Mining Standard*, returned to Australia by the *Sierra* on December 19.

A. S. WHEELER has resigned as inspector general of mines for the Chinese government and is on his way back to London.

W. J. C. SCRUTTON has resigned the position as manager for the South American Copper Syndicate in Venezuela, owing to ill-health.

J. B. TYRRELL is in the East Kootenay district, British Columbia, examining and sampling the Paradise mine, west of Invermere.

E. L. FORBES, local secretary of Butters Salvador Mines, has arrived in San Francisco from the mines in Salvador, and will spend the winter at Los Angeles.

BEN B. LAWRENCE made a visit of inspection to the Cornucopia mines of the Baker Mines Co., in Oregon, on his return from San Francisco to New York.

GEORGE H. GARREY, consulting geologist in charge of exploration work for the Tonopah Belmont Development Co., was at Salt Lake City this week, on his way to south-western Colorado.

H. C. BELLINGER has been appointed general manager of the Chuquicamata mine, for the Chile Exploration Co., in succession to FREDERICK HELLMAN, who is now chief consulting mining engineer to the Guggenheims.

A. H. COLLEMAN, general manager for the Seoul Mining Co., has resigned the active management of its Korean properties, and will devote his time to personal mining interests in the Orient and the United States. He continues his connection with the Seoul company as a director, so that the company will still have the benefit of his knowledge of the mines, which were developed during the past eight years under his organization and management from mere prospects into one of the best paying properties in the Far East.

The International Committee of YOUNG MEN'S CHRISTIAN ASSOCIATIONS, whose North-west headquarters are at Portland, Oregon, has just concluded a financial campaign at Butte for \$200,000 for a miners' Y. M. C. A. building. Among the large personal givers were C. W. Goodale, \$5000; T. F. Cole, \$2000 by telegram from Jerome, Arizona; also \$350 each from D. C. Jackling and N. B. McKelvie of the Butte & Superior; East Butte Mining Co., \$5000; John Gillie, \$500; and L. O. Evans, attorney for the Anaconda company, \$1000. The total subscriptions were \$202,475.

THE METAL MARKET

METAL PRICES

San Francisco, December 19.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	35
Pig lead, cents per pound.....	7.75-8.75
Platinum, soft and hard metal, per ounce.....	\$85-91
Quicksilver, per flask of 75 lb.....	\$80
Spelter, cents per pound.....	13
Tin, cents per pound.....	43
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, December 19.

Antimony, 50% metal, per unit.....	\$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.....	15.00
Magnetite, crude, per ton.....	6.50-9.00
Manganese, 50% (under 35% metal not desired).....	16.00
Tungsten, 60% WO ₃ , per unit.....	20.00

Advice from New York states that Great Britain has bought tungsten ore in Bolivia and the Argentine at \$18 per unit for the first quarter of 1917.

New York, December 16.

Antimony: No business is reported, and the nominal quotation is unchanged at \$1.50 per unit.

Molybdenite: A dealer asserts that an effort to corner the market has been partly successful. For 90% concentrate the quotation is \$1.75, but it is nominal for the reason that there is so little to be had.

Tungsten: One of the larger producers announces an advance to \$20 per unit, following heavy sales for both prompt and forward metal is lower; lead dull and easy; spelter is unsettled and dull.

EASTERN METAL MARKET

(By wire from New York.)

December 19.—Copper prices are upset by peace talk, re-sale metal is lower; lead is dull and easy; spelter is unsettled and dull.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Dec. 13.....	35.00
" 14.....	34.75
" 15.....	34.50
" 16.....	34.00
" 17 Sunday.....	33.50
" 18.....	32.50
" 19.....	32.50

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.24	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	...

Bradens produced 4,418,000 lb. during November, an increase of 400,000 lb.; Greene-Canaan, 5,100,000, a decrease of 900,000 pounds.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Dec. 13.....	76.00
" 14.....	75.87
" 15.....	76.75
" 16.....	76.25
" 17 Sunday.....	76.62
" 18.....	76.62
" 19.....	76.62

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	...

Continued strength characterizes the silver market, an upward tendency being apparent, the occasional recession indicating nothing unusual. Writing on November 23, Samuel Montagu & Co. of London say: "Enquiry is not confined to mintage alone, but embraces orders for general purposes, British and Continental, and also for the Indian Bazaars. The unfavorable views taken in India have caused a bear position to be opened in the London market—a state of affairs, in view of the statistical position, not without danger. It cannot be

challenged that the present condition of the market is more sound than when the spectacular movements in May last carried the quotation to 76.87c. During the intervening period the Chinese stock has been greatly reduced, America has been relieved of certain accumulations she then held, and the Indian currency figures, notwithstanding large continuous purchases for the Indian mints, show a declining tendency. The silver market has often lived up to its reputation of doing the unexpected, but the situation is such that further advances may be expected before the close of the year, provided no new factor intervenes."

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Dec. 13.....	7.90
" 14.....	7.75
" 15.....	7.62
" 16.....	7.62
" 17 Sunday.....	7.62
" 18.....	7.62
" 19.....	7.62

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	.....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Dec. 13.....	11.75
" 14.....	11.75
" 15.....	11.50
" 16.....	10.75
" 17 Sunday.....	10.50
" 18.....	10.50
" 19.....	10.50

Monthly averages

Monthly averages							
	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	...

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
Nov. 21.....	\$0.00
" 28.....	\$7.00
Dec. 5.....	\$8.00
" 12.....	\$8.00
" 19.....	\$8.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.20
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	...

TIN

Prices in New York, in cents per pound.

Prices in New York, N. Y.							
Monthly averages							
	1914.	1915.	1916.	1914.	1915.	1916.	
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36.10	48.25	51.49	Oct.	30.40	33.60	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.97	Dec.	33.60	38.71	...

Tin is quiet at 42.50 cents.

ANTIMONY

On the whole, the New York market is quiet but firm, with quotations ranging from 14 to 14.50c. It has been reported from time to time that munitions makers are likely to buy, but so far their business has not materialized. It is said by one authority that considerable effort is being made to obtain antimony free from the British restrictions, but without much success. Asiatic grades, of course, are subject to agreement that they will not reach the hands of Britain's enemies, just as tin and ferro-manganese are, and the would-be buyers are willing to pay 1/2c. higher to be free of the restriction.

Eastern Metal Market

New York, December 17.

The metals have been rendered quieter by the German peace scheme. Although Germany's proposal may not be accepted, and the general feeling is that it will not be, her announcement will drive home to consumers a realization that the War may be ended sooner than was expected, with the result that buyers are likely to become even more conservative than they have been. Should the War end suddenly it will have a profound effect on all metals. It is needless to emphasize the extent to which the direct and indirect demand has sprung from the ammunition makers. Another important development is Great Britain's further efforts to conserve her supply of copper. She has prohibited the use of the metal except for Government work, as well as forbidden all trading except under special permit. American copper prices are so far not affected, which demonstrates the strong position of the metal, and the solid way in which the producers are booked up for months to come.

Zinc has declined in a quiet market. It seems to have been more affected by the peace proposal than the other metals.

The scarcity of lead continues. Some talk is heard of manipulation being partly responsible for the scant supply.

Tin is dull and lower.

Antimony is firm, but quiet.

The high prices for pig iron, which range from \$30 to \$35 per ton at furnace, has caused buying to slow-up. For steel products, especially shipplates, the demand is as strong as ever, with both domestic and foreign shipbuilders clamoring for material. At the close of November the unfilled tonnage of the United States Steel Corporation was 11,058,542 tons, an increase of 1,043,282 tons as compared with October 31. Orders for nearly 500,000 tons of rails have been placed by the railroads for 1918 delivery, and the Pennsylvania Railroad is expected to place orders at an early date for 205,000 tons for delivery in that year.

A bad feature of the situation is the growth of railroad embargoes against material for export originating in the Middle West. They are trying to avoid the congestion of port terminals which so paralyzed traffic last winter. Of course, in one sense, the embargoes will have a salutary effect, otherwise they would not be declared. The embargo on various points in New England was raised December 10. Metals can be shipped and delivered to the brass mills in that district, but care must be taken not to ship in excess of needs, otherwise the embargo will be lowered again.

COPPER

Despite events of world-wide importance, which theoretically, at least, would seem to entail a depression in the copper market, prices are as firm as ever, if not a little stronger. The truth is that the metal is so thoroughly entrenched that sentiment cannot easily do it harm. The market has been quiet, and it was made more so by the announcement of Germany's peace proposal, but prices remained firm. Then, on Monday came news from London that Great Britain had forbidden all transactions in copper except under special license. All holders of the metal were ordered to furnish the Government with the details of their stocks and quantities due on contracts, with the further and more important stipulation that the use of copper was prohibited except for Government work. These strict regulations were designed, as were those of early in the year forbidding trading in futures, to conserve Great Britain's supply of the metal for war purposes, and also to prevent speculation which threatened to make the Government exorbitant prices for a necessity of war. Electrolytic dropped £3 in London (to £168) on the day of the announcement, but the Ameri-

can market did not change. The strength of the market lies in the fact that the entire production for the first quarter of 1917 is sold, and that fully 80% of the production in the second quarter is under contract. January copper is held at \$5.50c.; first quarter at 35c., second at 33.50 to 34c., third at 32.50 to 33c., and fourth at 31.50 to 32c. First quarter has been quoted at 36c. and upward. It is considered not unlikely that any of these prices might be shaded as a result of private negotiations. One who wants to sell copper has to search for a buyer who wants the metal, and a buyer has to search for a seller who has the metal, and the scarcity makes the latter not an easy proposition. The brass business is as heavy as at any time. Sheet brass is sold-up for the second quarter, except for odd lots. The American mills prefer to make sheets 10 to 12 in. wide which export buyers are taking, although abroad they really want sheets 20 in. and upward in width. J. P. Morgan & Co. is in the market for brass rods, sheets, and disks, January to May delivery. Of brass rods alone 5000 tons is wanted. The London market for spot electrolytic stood yesterday at £168. Exports of the month (including December 12) amount to only 8925 tons.

ZINC

Quotations in the past few days have been irregular, and the market on its face, is weak, yet some of the producers declare that January will see higher prices, basing their faith on fundamental conditions, which, they say, are sound. It remains true, however, that prices have continued to decline, and that 11.50c., St. Louis, and 11.75c., New York, could be done yesterday for the first quarter, with spot around 11.75c., St. Louis, and 12c., New York. For some reason zinc seems to have been more affected by Germany's proposals for peace than any of the other metals. Late December and January brass mill special is around 13 to 13.25c. Sheet zinc is unchanged at 21c., carload lots, f.o.b. smelter, 8% off for cash. Exports, December 1 to 12, totaled 1601 tons, which would indicate that they are slowing-up. The London quotation for spot yesterday was £57, or £1 10s. lower than a week previous.

LEAD

While the A. S. & R. Co. announced advances to 7.50c., New York, December 5, as reported a week ago, it has not been taking business at that level. On the 15th, however, it will begin taking orders for January delivery, the price to be fixed by its monthly average of quotations. Meanwhile the scarcity of near-by lead has continued the feature, and independents have been asking up to 8c., New York, for December delivery. That they have obtained this price has not been confirmed, but they have done business at from 7.75 to 7.90c., New York, with consumers whose needs were urgent. Intimations are heard that speculators had a hand in creating the scarcity of spot metal, but this has to be proved. On behalf of the producers it can be said that they are hampered by transportation difficulties. In the first 12 days of this month exports amounted to only 51 tons. The London quotation is unchanged at £30 10s.

TIN

The week has been a dull one, and devoid of interesting features. Importers continue to encounter difficulties in obtaining licenses to ship from England, and the supply of Banca tin is about exhausted except for a few unimportant lots. Arrivals this month total 675 tons, and there was afloat on the 12th 6228 tons, most of which is scheduled to arrive in December.

ALUMINUM

No. 1 virgin metal, 98 to 99% pure, is 63 to 65 cents.

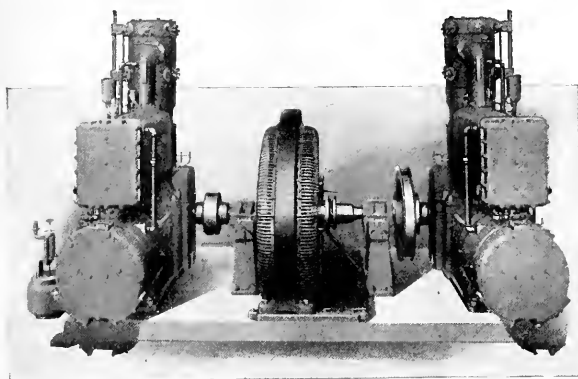
Industrial Notes

Information supplied by the manufacturers.

Improvements in Air-Compressors

The improvements described below relate to air-compressor design of the Sullivan Machinery Co. and have been introduced during the past 12 months. They include: (1) twin design for angle-compound compressors, either belted or direct connected; (2) plate air-valves of a distinctive pattern; (3) three-pass counter-current inter-coolers.

As the name implies, the twin-angle compound compressor consists of two complete Sullivan air-compressors of the angle-compound type set side by side on a common foundation and driven by a common shaft. As in the single units of this class, the intake cylinders are horizontal, and the high-pres-



THE TWIN-ANGLE COMPOUND AIR-COMPRESSOR.

sure cylinders vertical. The inter-cooler is horizontal, and is supported by the low-pressure cylinder and its frame. The connecting-rods for both members are attached to one crank-pin. As shown in the photograph, the common driving-shaft is provided with couplings at each end, so that either compressor may be cut out in case the amount of air needed over a considerable period is less than one-half the total capacity of the compressor. The belt-pulley, or in the machine illustrated, the motor, is supported on an independent frame and on independent bearings. The air-intake for each half of the machine is independent, and each intake cylinder is equipped with a standard double-beat, total-closure, unloading-valve. When the automatic unloaders on the intake-cylinders close and after the high-pressure cylinders have pumped out the air contained in the inter-coolers (which require only a few seconds), the unloaders on these cylinders open communication with the atmosphere, so that small quantities of air leaking in around the valve-stems and piston-rods are discharged to the atmosphere without being compressed to a pressure higher than the atmosphere. This prevents heating of the cylinders and maintains a nearly perfect vacuum in which the pistons move when the compressor is unloaded. Cross-head pins, crank-pins, guides, and other connections are thus entirely relieved from the friction to which they would be subjected in case any pressure remained in the cylinders during the unloading period.

The chief object in perfecting the twin-angle compound design was to provide a compressor of elastic capacity, capable of advantageous operation at any portion of its piston displacement.

As already described, the capacity of the plant may be cut in two by removing the bolts that hold the coupling together at either end of the shaft, thus allowing one-half of the machine to stand idle; the other half, consisting of a complete, independent, two-stage compressor, then operates at full capacity and efficiency as before. If desired, for short periods, the same results can be obtained by closing one of the inlet unloaders by hand. The unloaded compressor then turns over, without compressing any air, until it is again required by the engineer. If only one-quarter of the full capacity is sufficient for the conditions, as in mine development, starting a contract, or opening a quarry, one side of the unit is uncoupled, and one intake-valve removed from each cylinder of the remaining side, thus reducing the power required for operation as well as the air delivered. For three-quarter load, both sides of the plant would remain in commission, but on one side an inlet-valve would be removed from each cylinder. The regular unloaders, of course, provide complete elasticity of output at all times, on whatever basis the plant may be for the time; and the adjustments referred to are only made when the requirements suggested above are to obtain for days or weeks at a time. The advantages of the multi-unit air-plant are thus fully realized in this new twin-angle compound type.

Another interesting feature of the twin-angle design is that it enables the plant to run at the same speed as a single compressor. Two hundred and fifteen revolutions per minute would be considered out of the question for a cross-compound unit of 2200-cu. ft. capacity; but the 1100-ft. single-compound compressors of which this Sullivan twin-machine is made up operate with complete satisfaction at this speed, and their piston-speed is relatively low so that abundant opportunity is afforded for the flow of air through the valves, and the wear of the reciprocating parts is low.

As stated above, the pulley or motor and the part of the driving-shaft between the two compressor units are supported by separate stands and independent bearings. These bearings are adjustable for either side or lengthwise adjustment, a particularly important element in motor-driven machines. None of the weight of the motor is supported by the compressor bearings proper, so that the danger of motor destruction from burnt-out bearings is greatly reduced. A separate lubricating system is also provided for the motor-bearings.

The characteristic features of single-angle compound compressors, such as balancing of reciprocating forces, with resultant smoothness of operation and power economy, small floor space, accessibility, etc., inhere also in the twin-angle compound type. These are built in five standard sizes with a full load rating of 900, 1300, 1500, 1800, and 2200 cu. ft. of free air per minute. Sullivan twin-angle compound compressors are in extended service under varied working conditions, and are amply justifying the expectations of their designers.

Plate-valves for air-compressors are offered in a variety of designs by different builders. These valves are now frequently applied to compressors operating at high speeds and aim to secure rapidity of action, wide port opening with little wire-drawing effect, absence of care and wear, and a reduction in motive power. Speaking generally, the disadvantages of this class of air-valve are increased clearance-losses, complication in construction, and danger of breakage, with resulting damage to the air-cylinder, because plate-valves are frequently inaccessible and breakage is hard to detect in proper season. The accompanying illustrations show valves of the plate type designed by the Sullivan company, which have certain points of interest and advantage. As shown in Fig. 1, this valve is of a distinctive form, shaped like a group of thin, flat fingers, made from special rolled spring-steel. Individual fingers or plates are about $\frac{1}{8}$ in. long by $\frac{1}{4}$ in. wide. When in place, these valves are rigidly bolted at one end only to a steel guard or

pressure-plate, the other end being free. The guard-plate is curved to form a rest or stop for the entire length of each plate or finger when bent or lifted by the incoming or outgoing air. The guards also equalize the lift of the valves. In lifting under air pressure, the fingers exercise a rolling or rocking action against the guard, opening first at their outer ends. In closing, the fingers roll back their seats, the fixed ends closing first and the free outer points last. Advantages claimed for the 'end-rolling' action, as it is called, are that it is free from any bodily lift that would produce a hammering or slapping effect, and that it secures freedom from leakage



FIG. 1.

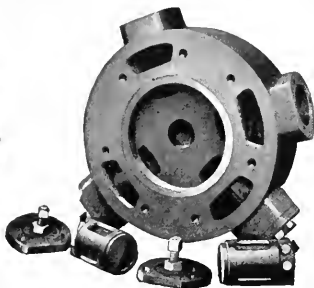


FIG. 3.

in a high degree. Fig. 3. shows how the valves are set, in plates or end walls, situated between the cylinder-barrel and the heads. The left-hand plate shows the cylinder side, the right-hand, the head side, of these end walls. The position and construction of these valve-plates reduces clearance loss to a minimum for this type of valve. The inlet-valves are placed in the lower half of the plates, the discharge-valves in the upper half. The cylinder heads are fitted with hand-holes and cover-plates, to permit easy removal of the valves without disturbing either the heads or the cylinders. In the high-pressure cylinders (or in single-stage compressors of small

cooler. In all Sullivan two-stage compressors the inter-cooler consists of a nest of tubes made of copper or aluminum, substances of high conductivity, through which the cooling-water passes. In ordinary practice, the current of water enters the inter-cooler at one end, traverses one-half of the tubes and returns through the other half to the starting-point. The air is caused by baffle-plates to take a zigzag course across the tubes, and comes in contact with them three times in passing from one end of the inter-cooler to the other. While effective for ordinary conditions and with cooling-water of ordinary temperatures, there has been some call for inter-coolers of unusually high effectiveness for places where the temperature of the circulating water is high, or where the highest efficiency possible is desired. For these conditions, the Sullivan three-pass, counter-current inter-cooler has been designed. It is shown on this page as applied to a twin-angle compound 'WN-4' motor-driven air-compressor. The inter-cooling surface of this inter-cooler consists of three nests of copper tubes, through each of which cooling-water circulates, entering at one end, traversing one-half of the tubes, and returning through the remainder. The ends of these tubes are expanded into headers, the outer header being bolted against a packed joint on the outer end of the inter-cooler body, while the other header, inside the inter-cooler body, is left free to move with the expansion and contraction of the tubes. Suitable baffle-plates are placed in the interior of the body, so arranged that the air, in flowing through it, is compelled to pass three times across each nest of tubes, thus insuring a thorough cooling effect. The course of air is opposed to that of the water, thus obtaining the greatest possible cooling value from it. The tubes and the three compartments in which they are placed are housed in a rectangular cast-iron shell.

Mining Decisions

OIL LEASE—AUTHORITY OF A GUARDIAN

Surrender of an oil lease to the guardian of a minor by the lessee in order to escape liability for rentals is of no avail, unless approved by the Court that authorized the guardian to make the lease.

Ardizzone v. Archer (Oklahoma), 160 Pacific, 446. October 31, 1916.

MINER'S LIENS—NOTICE OF NON-LIABILITY

A notice of owner's non-liability written in lead pencil and posted so as to be exposed to the elements on the compressor-house and on temporary structures at the collar of the shaft which were intended to be removed before certain workmen commenced work, is not a good defense against a suit to foreclose a miner's lien.

Phillips v. Snowden Placer Co. (Nevada), 160 Pacific, 786. November 9, 1916.

OIL LEASE—FORFEITURE

Where an oil lease required the lessee to drill a well within four months or pay a minimum royalty of \$80 per month thereafter, and the lessee did neither, it was held that the lease was voidable at the option of the lessor after the expiration of the four months' period, even though no express covenant to that effect was included in the lease, and a judicial decree of forfeiture should be granted at the lessor's suit to clear his title.

Brown v. Wilson (Oklahoma), 160 Pacific, 94. October 10, 1916.

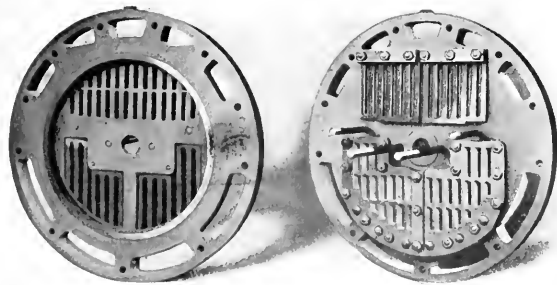


FIG. 2.

size) the plate-valves are placed in cages and arranged radially around the periphery of the cylinder-heads in the same manner as automatic poppet-valves are set on Sullivan compressors of ordinary type. Each cage contains two valves, each consisting of two fingers that run lengthwise in the cage. These are equipped with guards of the same form as those already described, as in Fig. 2.

The full advantages of the two-stage compression of air are not realized unless the heat generated in the intake-cylinder is thoroughly removed before it reaches the high-pressure cylinder. While cylinder water-jackets are valuable aids in this regard, this cooling depends in the main on the inter-

EDITORIAL

T. A. RICKARD, Editor

ACCORDING to a later ruling, every American patent runs its full life, irrespective of the time at which its corresponding foreign patent may terminate. So No. 835,120 of Minerals Separation American patent will lapse on November 6, 1923, although the original British patent expires on April 12, 1919.

WE note an item in the daily press concerning Albert Freeman, who was indicted several years ago jointly with Julian Hawthorne and William J. Morton for swindling the public by means of a mining prospectus. Freeman was sentenced to five years in the penitentiary. On appeal, he was granted a new trial and released temporarily on heavy bail. On December 10 in New York he pleaded guilty to the charge of conspiracy to defraud investors, through illegal use of the mails and was fined \$3000, which he paid. His attorney stated that he pleaded guilty to the indictment because he was "no longer able to meet the aggressiveness of the Government." It only remains for all good citizens to commend the Government for its "aggressiveness" in checking swindling through misuse not only of the mails but of legitimate industry.

GERMAN peace overtures have done as much damage as an army corps on the war-path. Wall Street cut a sorry figure during the ten days in which it was at the mercy of peace and rumors of peace. The 'peace scare,' as it is pathetically called, must have caused a great many million dollars to change hands and to that extent it made a broker's holiday, but it was a poor spectacle. However, in Japan they do things even worse. The Tokio stock-exchange had to be closed "after one of the most riotous days in its history." Of course, we do not know how riotous Japanese brokers can become, but judging from their prowess in the field of battle we may assume that it was 'some riot.' Meanwhile thoughtful men must be asking each other what will happen when the dove of peace is seen, if such a welter of speculative panic can ensue from a sound that is not particularly like the beating of her wings.

H. C. L. is a Western abbreviation for the high cost of living, concerning which a lot of nonsense is being written in blind disregard of the fact that it is mainly the consequence of a love of luxury that a period of excessive prosperity has engendered. Unless we are much mistaken this confusion of ideas extends to the mining industry, in which the intensive exploitation of ore reserves is causing an extravagance in management that is not all due to the high cost of machinery or supplies but

is traceable in large part to the rush to become rich, that is the haste to earn dividends. When the orgy of production is over, the managers of mines will have to face all the dreariness of the proverbial 'morning after.' Whether the gutting of mines is commendable or not depends upon a fundamental difference of opinion, as to whether it is proper to realize upon the ore in a minimum of time and a maximum of immediate profit or to operate a property as an investment that will last for a human lifetime. In this, as in other matters, a sane economy lies between the extremes.

INQUIRIES have been received from a number of localities in California concerning annual assessment work on unpatented mining claims. Those who desire a copy of the latest California mining laws would do well to request the State Mineralogist, Ferry Building, San Francisco, to send Bulletin No. 71, which contains the mining laws, county maps, and statistical information regarding mineral production of the State in 1915. The California law regarding annual assessment is as follows: "Sec. 1426 l. The amount of work done or improvements made during each year to hold possession of a mining claim shall be that prescribed by the laws of the United States, to wit: One hundred dollars annually." The State law makes a much-needed provision, as follows: "The failure or neglect of any locator of a mining claim to perform development work of the character, in the manner, and within the time required by the laws of the United States, shall disqualify such locators from re-locating the ground embraced in the original location or mining claim or any part thereof under the mining laws, within three years after the date of his original location, and any attempted re-location thereof by any of the original locators shall render such location void."

READERS of this paper indicate what is interesting by the letters they send to the discussion department. The prospector and his fortunes appears to be a topic that cannot be suppressed, for in this issue we have two letters dealing with it. Mr. John A. Roos makes some incisive remarks, such as that the training of the prospector has not kept pace with the training of the engineer, so that the latter has usurped part of his function as a scout. That the explorer must be an optimist, one must agree, but that he must be ignorant of scientific aids does not follow. For the suggestion of a 'Prospector's Special' we can arouse no enthusiasm, but it is in accord with those pictorial developments in modern life that the cinema typifies. However, we like

Mr. Roos's humane and humorous treatment of the subject. On the other hand, Mr. W. H. Storms finds less fault with the prospector than with the conditions that have rendered the old 'hit or miss' method of exploration no longer successful. Mr. Storms is in a position to know, for, while a technologist himself, he numbers many of the old-time prospectors among his personal friends. We commend his diagnosis of the trouble that has befallen the pioneers of mining.

ACCORDING to letters received from mining engineers still remaining in Mexico, the principal mines at El Oro are working full time and the workmen are being paid in silver. Coin is hard to get and a shortage is anticipated despite the premium offered. Small strikes among the men have been settled promptly. At Pachuca the depreciation of paper money makes business difficult. The Government refuses even to receive its own money in payment for taxes and freight. The mining companies are compelled to use gold and silver, but the scarcity of this means of exchange hampers dealings. Several strikes, due to the inability of the peons to understand the financial situation, have interrupted mining operations, but not for long. Another difficulty is the scarcity of cyanide. This has curtailed the capacity of the mills. Moreover, the exorbitant price of cyanide, caused in part by the withdrawal of large stocks bought by speculators, will render it impossible for the poorer properties to continue at work. The destruction of trains, the strikes among the railway employees, and the raids of bandits render operations so precarious that it is impossible to look ahead. Correspondents in localities so wide apart as Pachuca and Tequila agree that the one thing that would aid the existing Government in restoring order would be a loan. Without money the powers that be are helpless. On another page we quote the latest decree concerning the export tax on metals. The reduction of 3% on the gold and silver will be helpful.

HOW the metal markets are dominated by groups of foreign traders backed by big banks is explained clearly in a chapter on 'Buying Combinations in the Metal Market' appearing in the report of the Federal Trade Commission dealing with 'Co-operation in American Export Trade.' Those engaged in mining operations will find a good deal of interesting information set forth clearly in the chapter to which we refer. What these international—or, more correctly, non-national cartels and syndicates have done in fixing metal prices and in otherwise regulating the market to suit their own ends ought to be known to every intelligent mine-operator. We have referred to the subject frequently in these columns. The official report may be more convincing. Incidentally, we may refer to the controversy raging in Canada—chiefly at Toronto—over the two shipments of nickel to Germany on the submarine *Deutschland* as disclosed by the *Providence Journal*. We have been quoted in this connection, and not improperly. In that controversy we shall take no part, for it is tinged with local

politics and an evident effort to injure the International Nickel Corporation. But we do suggest, not for the first time, that a searching investigation into the metal-selling business would prove illuminating not only to the trade and to the several governments but most of all to those engaged in mining, because it has a vital bearing upon the disposal of the metallic products they are engaged in producing.

F. A. VANDERLIP is known as the president of the National City Bank of New York, an enterprising and intelligent organization that is doing a great service for American business abroad. But he is more than a banker, he is a good citizen, as is made evident by the text of the recent address delivered by him before the Bankers Club of Chicago. We would like to reproduce all of it for the benefit of our readers, but the subject is outside our immediate province and we shall have to content ourselves with a brief quotation: "A part of the country has been submerged in prosperity and its sense of proportions and relationships has certainly been dulled. Another, and a greater part, which has only experienced this prosperity in a reflected way and has viewed both the War itself and its reflex action upon our industries in a somewhat far-away and detached manner, has developed a point of view of aloofness from the world's tragedy. It has been a spectacle, but it has not gripped their souls. They look with horror on the carnage, with satisfaction on the profits, but with an unrelated sort of superiority to both, and feel that as a nation it is best for us to avoid being involved in any of the consequences. . . . To me, this seems an utter lack of imagination, a blindness of vision, a complete failure to understand the unity of the industrial, commercial, and financial world." We remember a banker early in 1893 in the Denver Club deriding the successive failures in Australia and we ventured to suggest to him that the people of Denver might feel the financial perturbation of events even in cities so distant as Melbourne and Sydney. In July of that year 13 out of 17 banks closed their doors in Denver. The warning given by Mr. Vanderlip is timely.

ON another page we give the full text of the Supreme Court decision in the Minerals Separation case against James M. Hyde. We believed that our readers would be glad to have the *ipsissima verba* of the Court, rather than an abstract or summary prepared by anybody else. However, after the text had gone to press we were notified of three errors in the printed copy of the decision as sent to us, namely, (1) in line 15, second column, of our page 944 "tenth of one" should precede "per cent.," (2) in line 20, second column of page 944 "tenth of one" should precede "per cent.," and (3) in line 12, first column, of page 945 the word "impossible" should be "clear." In announcing the close of this particular litigation, in our issue of December 16, we made some suggestions. Further comment will be deferred until the policy of Minerals Separation is announced. In

New York it is believed the decision will pave the way for amicable adjustment of the controversy—by a reasonable arrangement for royalty, we presume. The number of American infringers is given as 234 and all of them will be given a chance "to come to time." If any one of these mining companies prove recalcitrant, as we expect they will, then demands for injunction and suits for damage will be started by the successful patentees, followed by an accounting of the profit derived from the use of the flotation process. The Jackling companies are likely to file bonds so as to enable them to proceed with their operations pending a settlement, amicable or legal, as events may decide, of the controversy. The Miami Copper Company declared \$299,396 as the profit made in November on that portion of its output that was treated by flotation, namely, 120,988 tons. We note that the idea of adjudging the profit arising from patent No. 835,120 by the saving of oil, as determined by deducting what is used from the limit specified in the patent, has been brought forward in Boston. According to this ingenious interpretation of the law, the Butte & Superior would deduct the value of the 18 pounds of oil used per ton from 21 pounds—or over 1%—on the supposition that the use of any quantity over 1% does not infringe. An announcement of the Minerals Separation policy should be forthcoming at an early date.

Announcement

Our readers will have become aware, from frequent references to the subject in the daily press and in our own columns, that the price of paper has risen considerably, partly owing to the increased cost of the raw material of manufacture and partly by reason of the arbitrary action of the manufacturers themselves. The cost of the high-grade paper that we use has risen 60% during the past twelve months. This may be compared with the statement of the Associated Business Papers that the average advance among 36 publications has been 70%, the figures ranging from 35 to 250%. Thus the increased cost to us is slightly below the average; but, as can readily be surmised, it may rise further at any moment. We have been notified of a further advance on the day this is written. The net result is that the mechanical cost of producing a copy of the MINING AND SCIENTIFIC PRESS is 2½ cents more than it was a year ago. This represents an addition of \$1.30 per annum, and there is no assurance that it will not become more. At \$3 per annum, our readers pay 5.77 cents per copy, whereas the direct cost—of paper, printing, and postage only—is 10 cents at this time. All of this is stated in the frankest way in order that our subscribers may understand the reason for the decision, now announced, to increase the subscription to \$4 per annum. At that figure it is still \$1 less than the rate charged by other technical journals of the same class. We are the less unwilling to take this step as it is one that has been taken by some of our contemporaries, for similar reasons, and because it is our intention to incur greater expense in making the MINING AND SCIENTIFIC

PRESS increasingly valuable to all those engaged in mining. We take this opportunity of announcing that Mr. W. H. Storms, editor of this paper before 1906 and a mining engineer of varied experience, particularly in the actual work of directing underground operations, has rejoined the editorial staff. In addition, we are glad to state that Mr. Courtenay De Kalb, associate editor from 1908 to 1910, and a technical writer of acknowledged distinction, combining the experience of the mining engineer and metallurgist with the rare faculty of clear and incisive exposition, will also become associated with the present editor in the early days of the new year. The division of editorial work will enable Mr. De Kalb and Mr. Rickard to make frequent journeys of observation to the principal mining regions and give the readers of this paper first-hand information conveyed in an illuminating manner. In short, the MINING AND SCIENTIFIC PRESS is growing with the industry to the service of which it is dedicated.

Electrolytic Zinc at Trail

In this issue we conclude a description of recent changes in smelting practice at Trail. Of these changes the most interesting is the successful introduction of electrolysis for the extraction of zinc. While the methods of leaching and precipitation in use are still undergoing improvement from month to month, enough has been done to demonstrate the success of electrolytic refining and fully to justify the metallurgical designs of Mr. E. H. Hamilton, with whose name the new departure is not improperly identified.

It is worth while to review the events that led up to this result. Electrolytic zinc in British Columbia was associated with the name of French. Andrew Gordon French was a Scot from Glasgow; at one time he was technical manager of the refinery business conducted by the Sheffield Smelting Company, at Sheffield, in England. In 1909 he came to Victoria, B. C., and made experiments on zinky ores, following a little experience that he had had with the Parnell and similar obsolete processes at Swansea, in Wales. His work at Victoria was sufficiently successful to lead to the organization of a company intended to exploit the process he had elaborated. In 1911 he moved to Nelson, where he obtained the use of an abandoned municipal power-plant and conducted experiments on a larger scale, producing electrolytic zinc of high quality from various ores mined in the Slocan district. This came to the notice of the Consolidated Company at Trail and it is stated that representatives of the company went to Nelson to make tests on the Sullivan ore at French's plant. The Sullivan mine had been acquired by the company in 1911 and it gave promise of becoming a big thing. The tests made at Nelson were sufficiently encouraging to cause the Consolidated Company to make a contract for the purchase of the sole rights to the French process in Canada, but nothing seems to have been done until 1914 when the process company appointed one of its directors, Mr. Thomas French, the son of the inventor, then deceased,

to advise the Consolidated Company in the erection of a 1-ton plant. What happened then is a matter of controversy. Mr. French asserts that obstacles were placed in his way but that in spite of this lack of co-operation the plant was worked successfully in accordance with his directions. The contract, he says, was not fulfilled, so the French Complex Ore Reduction Company, as the process syndicate was called, cancelled the agreement and withdrew from further participation in the experimental work at Trail. The gentlemen at the big smelter are unwilling to ventilate the dispute that ensued, but we infer that they found in Mr. French's method an echo of older patents and in his process too many details requiring further elaboration.

On his return to Nelson, Mr. French continued to have the backing of Mr. J. O. Patenaude, a local jeweler and a sagacious man of business. Mr. Patenaude took steps to obtain Government assistance, and succeeded, after a favorable demonstration of the process had been made at Silvertown on zinc-lead ore from the Standard mine. With the support of Mr. R. F. Green, the representative for the Kootenay in the Provincial parliament, he secured a grant of \$40,000 for the erection of a plant. He also obtained the use of the old electric smelter at Fairview, on the outskirts of Nelson, where last summer an electrolytic plant was being built under the supervision of Mr. French. This plant includes a McDougall roaster left from an earlier metallurgical effort. The leaching department includes two vats and a filter-tank aided by vacuum. The electrolytic department contains 37 cells. It is expected to add a lead refinery, using the Pattinson and Parkes methods for separating the silver. Mr. French claims that he can extract 90% of both metals from a 15% zinc and 30% lead ore. He will use sheets of rolled zinc for starting and then a lead anode. The show of secrecy concerning details may be excused on account of the feeling engendered by the controversy with the Trail management but it seems to us that the Provincial government, as a patron, should insist on the publication of the fullest information in return for its subsidy.

Into the controversy over patents it is unprofitable to go. It is proper to state, however, that Mr. French claims originality (1) in the use of manganese to prevent corrosion of the cathode and to maintain the purity of the electrolyte; and (2) in the use of sodium bisulphate, or 'nitre-cake,' which is added to the ore while it is being roasted, for the purpose of converting the metallic oxides into sulphates. It is asserted also that the zinc sulphate goes into solution before the iron sulphate, which remains undissolved if the leaching is stopped at the right moment. He further asserts that his patents are being infringed both at Trail and Anaconda, but as he confessed to the present writer that he had not made a search of the patent record, this assertion may be imputed to the natural eagerness of an inventor. The Anaconda management has looked into the matter and finds that French's American patents do not conflict with the process in use at either the Washoe or the Great

Falls plants, which follow the method designed by Mr. Frederick Laist. The Consolidated Company acknowledges the taking of an option on the French patent, for which a royalty was to be paid in case it was used, but the metallurgists at Trail assert that after French had erected and run his trial plant, they found it unsuitable and since then they have developed another electrolytic process. At Trail sodium sulphate is not used, and as for manganese, that exists in the Sullivan ore. Presumably if a reagent is a natural constituent of an ore, and produces sundry reactions of a beneficent kind, the use of it cannot be claimed as an infringement, even if the patent be validated. The manganese idea in electrolytic zinc refining is like that for the formation of magnetite to protect the lining of a copper converter, as patented by Krejci and Wheeler; it is difficult to prevent the formation of magnetite under the conditions specified and the desired result was obtained in converters long previous to the publication of the method.

Passing from these disputable points we come to the main question of the dependence of economic success in electrolytic refining upon cheap electrical energy. It is difficult to obtain accurate information concerning the cost of power. The big metallurgical company usually obtains its electricity from a power company and an inquirer is told the figure in the contract, but the power company is likely to be a subsidiary of the smelting company, so that the bedrock price is not disclosed. At Trail a nominal figure of $\frac{1}{3}$ cent per kw.-hour, or \$20 per hp.-year is quoted. The little plant at Nelson is said to obtain its power from Bonnington Falls at \$13.50 per hp.-year. It may be taken, as a rough estimate, that in the West it is possible to generate power for \$10 per hp.-year, this sum including attendance, maintenance, and interest on a 20-year redemption of the capital involved. Of course, the cost depends mainly on the rate of amortization, which is based upon the estimated life of the enterprise. In a new country most people do not look far ahead and enterprises change hands at comparatively short intervals—hence a high rate of amortization; but given a metallurgical plant like that at Trail or Great Falls, well-established and strongly supported, assured of an abundant supply of ore, it would be safe to cut down the interest for redemption to a low percentage over a long period. What the cost of producing zinc in this way is has not been disclosed. That interesting financial gossip, the *Boston News Bureau*, stated recently that at Trail "the actual cost of making zinc from a 10% zinc concentrate should never exceed two cents per pound, and where power is \$10 or \$12 per horse-power, it should not exceed $1\frac{1}{2}$ cents per pound." Presumably 'never' stands for 'not' and the cost mentioned may be meant to cover only the roasting, leaching, and precipitation, not the mining and concentrating. The statement is not clear, but it is likely to be taken to mean that spelter can be made for 2 cents per pound as against an average pre-War cost of 5 cents. If a guess is permissible we would hazard 4 cents as the cost of producing zinc from the Sullivan ore at Trail.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

The Prospector Again

The Editor:

Sir—I have read with interest the views of many as to 'What is the Matter with Prospecting?' Having mined and prospected in several States during the last ten years, my views as a prospector may be of interest.

The education of the prospector has not kept apace with that of the engineer. Were the problem put to me, I would analyze it by dividing prospectors into three classes: Class A would include the men who through their powers of observation, technical reading, and similar accomplishments, have placed themselves in a position to form a fairly good idea of prospective mining values; they are the scientific prospectors. When our prospector gets this far along, he gains something of the engineer's pessimism and is likely to confine his search to located ground, for a lease or a bond-and-lease on property, the value of which a less experienced owner is not aware. The hardihood and natural liking of the game should make this man of value, but the engineering staffs of the large companies seldom employ him and few have the means to go to the hills for the season.

In Class B, I would put those who prospect by the hit-or-miss method. Early in the career of one of this class he is likely to find a cropping imposing as to size but barren of possibilities. Not being able to appraise same, he decides to read up, so he sends for a professional paper on his district; upon opening it he finds a photo-micrograph of a quartz mica-hypersthene-diorite and is dumb-founded; turning farther, he finds he never could pronounce or remember such a name, and finally decides that anyone who would call granite by such a name is crazy. Next he meets an older Class B man who tells him that the names, and such, are for the same purpose as a doctor's prescription in Latin, namely, so you cannot fill it at the grocery, and that you can't tell a thing about the rock beneath except by digging, and he digs. A little rightly-applied information would start him toward Class A. He is also a loss.

In Class C, I will put the man whose education is about equal to figuring up a grub bill. He is as likely to hold the technical man in great regard as not, or to say "Shucks, one of them book learnin' fellers told old Jones he'd never hit nothin' and look at his mine now, workin' six men." But don't ridicule this man, he's likely to have eyes that see and a memory a mile long, and he makes a strike oftener than a Class B man. He doesn't carry a head full of technical phrases, but a picture gallery crowded with rock-pictures gathered through the

years as miner, mucker, and prospector. He's more of an explorer than A or B, always with an eye for placer and for such formations as he has seen that held ore. An optimist? Well, I guess yes.

Now, say all three have a claim of about equal prospective value for sale. A will generally be fair in terms, but B—well, he wants a million or two cash and the trusts 'ain't goin' to get his claim for a song." C may ask a big figure, not knowing the value of money, but stack a little pile of gold in front of his eyes and you have generally bought something. Now, A is apt to keep abreast of the times, but put him in the field or he's a loss; B and C need the handling advised for a mule—just convince him you know more than he does, by using proper language. No, I would not club him over the head with anything he could not digest. He'd fight shy. "But," you say, "how can we get to him as an individual, for he's scattered all over the Cordilleras, and he holds us in such light esteem, he'll be shy?" Well, the feeling is mutual in many cases, so you've got to take a lesson in pulling together, not bucking, or you'll both continue to ask why good properties are getting harder to find. Generally speaking, you are older and should know more than he does.

Now here's my plan, Utopian as it may seem to some, and it calls for co-operation by everyone directly concerned in the mining industry. Say I've got all this co-operation that the U. S. G. S., A. I. M. E., or other associations or individuals can give. The U. S. G. S. should handle this work, for they are equal to it, if the pork-barrel doesn't get all the kale. Co-operation comes in here, for it takes money. A dozen geologists, good 'mixers,' to begin with, should receive a special treatment which would leave them just ordinary humans, able to talk mining to B and C prospectors so they'll 'savy.' I'd get six specially designed railroad-cars and in big letters, label them the 'Prospector's Special.' Take the moving-picture outfit along and in the mining towns or all places with mineral possibilities, hire the town-hall or theatre for a night or two. Show mining scenes, prospecting outfits in the field, croppings of prominent mines, and where possible, from prospect to mine. Give a little talk at the same time, the idea being to convince people that prospecting is not always humbuggery, but an honorable calling; one in which to strive to excel.

You say this is not educating the A-B-C mixture. No, it's just boosting the game, encouraging him a bit, putting him right with the public. We'll go with him to the ear—he's read the announcements and has come out of the hills. We're going to be here a week, you know,

not a fly-by-night. Into the car comes Mr. Rainbow Chaser. Mr. Mixer doesn't see the bacon tracks or need of a shave, but gives him the 'glad hand' and up a notch goes Mr. Geologist with his more primitive brother, and his interest is excited now that he feels at ease. He sees cases of rock ingeniously arranged; croppings from the 'Wonder' and ore from below. Croppings from above orebodies predominate—that is his problem. He can't remember the scientific names put there for A, but he can judge rock and read values. The croppings will be observed so minutely that he'll have a collection worth while for the picture-book he'll open in his head as he goes back, not a batch of meaningless words.

In the 'rare' mineral collection he has seen a sample of stuff he passed over years ago and no one of his friends knew what it was. He knows now, for the picture-book has kept its colors well; it is likely to result in a discovery. Also he's brought along rock for comparison and he takes back a publication that reads like a story-book in non-technical language and after he's read it through he has an idea of primary and secondary orebodies and what to waste no time over. He's on his way to Class A, his prejudice scuttled and sunk with all hands, a missionary now, not a knocker.

It is 1925 now and we read in a 1916 M. & S. P. that someone said all worth-while orebodies have been found and we laugh as we read of the new mines coming in and the generally prosperous condition of mining and decide that most assuredly do advertising and education pay.

Ravalli, Montana, November 25. JOHN A. ROOS.

The Editor:

Sir—I have refrained, until now, from attempting to add to the already too heavy burden of the prospector, who, a number of our friends insist, has "something the matter with him."

I have known the prospector quite intimately for many years, I have watched his career with interest, and I have reached the conclusion that the trouble he has experienced in recent years is not so much his fault after all. The 'matter' is that there is an entirely new dispensation in affairs that affect him profoundly. The old-time prospector is dissatisfied with his present opportunities for finding rich ore deposits, and even more so with his chances of turning any 'find' he may make into a sudden fortune. By nature he is an optimist, with an inborn faith in his own ability and judgment, as far as the search for and the ultimate discovery of a rich mine is concerned, and he used to feel entirely competent to sell a promising prospect to good advantage should he be so fortunate as to find one.

A few years ago the prospector went into the hills alone or in groups, and 'ran over' the country, looking for minerals. So rapidly did he move that most people thought his work was done carelessly, and that he was prone to overlook much that was valuable, but the history of most mining districts shows that, generally speaking, such was not the case. Unless a vein or ore deposit was obscure, he was pretty likely to discover it and it was

only those deposits that required considerable geological knowledge and prolonged exploratory work before discovery that escaped him. The first men to go up Gold Run in the Black Hills discovered and located the Homestake; any man that ever saw a mineral deposit, who might have chanced to run across the huge outcrop of the Bunker Hill & Sullivan mine, in the Coeur d'Alene, would have at once recognized it as a great possibility and promptly have located it; and so with a great many others. It is true, some of the best mines, like the Granite Mountain, at Philipsburg, Montana, were not rich, nor particularly favorable at the surface, but the good ones usually gave sufficient evidence of their potential value to make them look attractive to the prospector.

What was it that made the business of prospecting so alluring to a large number of men throughout that wonderful period to which we refer as 'the early days'? It was the constant hope, not ill-founded, of finding rich ore that could be shipped at good profit, or the belief that any discovery possessing an attractive appearance could be sold at a price which would insure to the fortunate discoverer at least a competency, if not a large fortune.

A party of several prospectors found the McCracken mine years ago in western Arizona. The ore was rich, and in a short time the lucky discoverers sold out for a large sum. One of them chartered a special train to take himself and family on a trip to Washington. He lasted a year or two and then, flat broke, returned to his old business of prospecting. But was he again fortunate? Indeed, he was. He made two or three fortunes later by lucky discoveries, though none of them as valuable as the first. A party of ten men went prospecting in the Black Hills in 1879. They had been out but a few days when they found a large mass of schist and quartz carrying gold. They named it the Grand Junction. Before they had done development work to the extent of \$2000 they sold out for \$125,000 cash. The mine was not worth it, but they got the money just the same. Another crowd discovered a small rich streak in a big vein at the side of the road a few miles from the Grand Junction and not far from the town of Custer. They called it the Telegraph mine, and within a few weeks disposed of it for \$75,000 cash. Again, the property was not worth the price, but that was learned later. The Quijatoa in southern Arizona, a rugged hill on the side of which was a plaster of high-grade ore, was discovered, located, and sold with scarcely any development work, for \$450,000. It was one of the dismal failures, but the losers were millionaire Comstock miners and could stand it. The experience did not deter them from taking other chances elsewhere.

These are but a very few instances of large fortune, quickly acquired by the humble prospector. The annals of mining in the West teem with just such stories of rich strikes, high-grade ores, fortunes almost over night, and stampedes from place to place—White Pine, Pioche, Reese River, Tuscarora, Tombstone, the Black Hills, Leadville, and Cripple Creek. More recently we have

had Nome, Tonopah, Goldfield, National, and a dozen others of less spectacular character, and now it is Oatman, in Arizona.

In those days the prospector was all right. He was independent and needed no other incentive than the opportunities of his calling to urge him to seek success. But now—it's different. In those days he penetrated everywhere; no desert was too threatening, no mountain too rugged, no forest too impenetrable, and no danger too great. He went, he saw, he located, and sometimes he won. The easy good things—either ore deposits or capitalists, are numerous no longer. The prospector still goes afield, but the railroad and the automobile have to a great extent displaced his burro and pack, greatly reducing the dangers and hardships of his occupation, but if he has been in the game very long, he no longer really expects to sell a ten-foot hole for a half-million dollars more or less. He knows that the prospective purchaser, if he ever gets one, will be discriminating, exacting, and hard to please. He knows that the man with the money is no longer satisfied to cheerfully hand out his certified check after giving the prospect the 'once-over,' for if he is 'wise to the game' he sends an experienced engineer and geologist to investigate. If the report is favorable, he may send another, and possibly several others in succession. Not only does he have a most rigid inquiry made as to the amount of ore available, but he wants to know its probabilities for the future beyond what actually has been exposed by development. Then there is the question of the metallurgy, which has to be investigated to a finish. The capitalist or his engineer must know the methods to be employed, the cost, and everything else that in any way has any bearing on the matter. After having ascertained all concerning the property that can be learned, and as much as possible of that which lies wholly in the future, he coolly calculates all the chances for and against success, enlarging on the latter, and finally makes up his mind. If the prospector makes a sale, it is at a price far below his hopes, and with terms attached that would make an old-timer shiver, if not quit the game in disgust.

The prospector has learned that mining has been divested of much of its glamor—has been reduced to a scientific calculation of cold dollars and cents. Capitalists no longer run a race with each other over hundreds of miles of mountain or desert to be first to reach the owner of a prospect. Today the prospector will be fortunate if he can succeed at all in bringing the attention of capital to his fairly well-developed property. Not only must he have an attractive showing, but it must be easily accessible, preferably by railroad, and if necessary, by automobile. Long stage-coach rides and journeys in the saddle are no longer considered as trifles by the wealthy comfort-loving investor. The prospector must be able to show that not only has he an excellent prospect, but he must be able to show that he also has available, if not actually owning, water and timber, and some inexpensive means of securing or generating power, for all of which he must be willing to accept a moderate

price, and then, worst of all, he must wait for months, or even years, before he can get his money.

There is no one thing alone that is the matter with the prospector. It is the entire change in conditions which have come about in recent years, that have nearly driven him out of business. A return to the old-time reckless way of doing things is neither possible nor desirable, but if the prospector can get into a new field affording anything like the opportunities of 30 to 50 years ago, he will quickly be in evidence once more, and will flourish too, but never again in the same old way.

San Francisco, December 25.

W. H. STORMS.

Black Sand

The Editor:

Sir—During the summer of 1900 I had an opportunity of witnessing the natural concentration of beach-sand mentioned by Mr. Herbert Lang. I was operating a string of sluice-boxes on the beach, about nine miles above Nome, and at the time when the big storm came, in August, the sluicers had almost completed the job of washing that part of the beach lying between high-water mark and the tundra, for almost 10 miles along the coast west of Nome. The so-called bedrock was simply a clear white sand, on which the pay-streak usually lay in alternate layers of black sand, one to four inches thick, then ruby sand of about the same thickness, then the top dirt of about four feet. Sometimes the pay-streak was not on the white sand, but a foot or so deep, and again there would be several streaks of black sand at different depths, and always the ruby sand over the black sand, with the classification of each material very clear.

Of course, the beach had been pretty well turned over in 1899 by the rocker men, who simply stripped the top dirt and worked the richest of the black sand in their rockers, but they overlooked patches here and there, so that I was able to see exactly how the original formation had lain. In one of these patches the pay-streak was fully six inches thick, and about 12 ft. across, and carried about \$1.50 to the pan. This was a little bonanza. Well, the big storm came and raged for three days, leaving the beach in exactly the same condition as it was before any work had been done. Naturally we were curious to know if there was any 'pay,' and with the first hull we began panning. To our amazement we found a thin streak of black sand less than a quarter of an inch thick, and carrying gold directly on top of the whole formation. We immediately set up a 'long tom,' which was simply the end box from our sluice in which we had ten feet of plates. Turning in a small stream of water from the tundra, we began shoveling in, using a pyramid grizzly to keep the coarse material from scouring the plate. Two of us worked about six hours when the storm drove us off the beach again. We cleaned up the amalgam, retorted it, and obtained close to ten ounces of gold which at that time had a trade value at the Nome stores of \$16 per ounce. After the storm had subsided again, we prospected in vain. The black sand and ruby sand

were there in streaks, just as they were originally, and there was some gold. We tried at different places along the beach for miles and could make about three dollars per day per man, but we never found what was considered good 'pay.'

FRED, G. TYRRELL.

Selby, December 4.

Handling Mexican Labor

The Editor:

Sir—Sometime ago I had an opportunity to go underground at the Dos Pilares mine, near Nacoari, in Sonora, Mexico, and there I saw a method of handling Mexican laborers that was entirely new to me. With a foreman as guide, I and two friends stepped on the platform of the cage, which took us down into the mine. As we approached the stope, through a cross-cut from the shaft, the sound of music came to my astonished ears, nor did it cease when we entered the stope. Here was a great chamber nearly 100 ft. square cut in the heart of a great orebody, and not a single stick of timber for support was in sight. Haste was being made, however, to fill the stope with waste drawn down through a raise connecting with a big glory-hole on the surface. The chamber was well lighted by numerous incandescent electric lamps. Near the centre of the excavation, but a little to one side, sat a Mexican youth at a table over which was suspended one of the lamps. Over against a wall, a young fellow lounged carelessly while vigorously playing a harmonica, which he encompassed with his cupped hands alternately uncovering and again closing his hands over the instrument with the rhythm of the music. Near him three or four other men were stretched out full length on planks, apparently sleeping. Not far away several others were enjoying a game of cards, a number of men standing by interested spectators of the game. The appearance of the foreman made no difference to the men in their pleasant diversions. The fellow with the harmonica never missed a note, the card players seemed unmindful of his presence, and the sleeping ones continued to sleep. There were, perhaps, 60 men in the stope, of whom all were at work except those engaged as described. Each man wore on his left breast a disc of brass, displaying a conspicuous number. Those who were at work were either shoveling waste rock into a wheelbarrow, trundling a wheelbarrow from the shoveling place to the 'fill' at the opposite side of the stope, or taking it back empty to be re-filled. As each man with his loaded barrow passed the youth at the table, he would call out the number of his tag, whereupon the clerk would tally a mark opposite the number called. At the end of the shift, each workman was credited with the number of loads he had moved from the shoveling place at the foot of the raise to the fill across the stope, and on this basis he was paid—a good scheme, no work, no pay. The foreman asked: "Ever see anything like this before?" I replied that it was entirely new in my experience, and he remarked, "Well, it's a good thing to remember. We have to treat these men much like children, and we have found that it works fine." It un-

doubtedly did, for the stope was being filled rapidly and cheaply, and the workmen all appeared to be well satisfied.

H. T. W.

Berkeley, December 22.

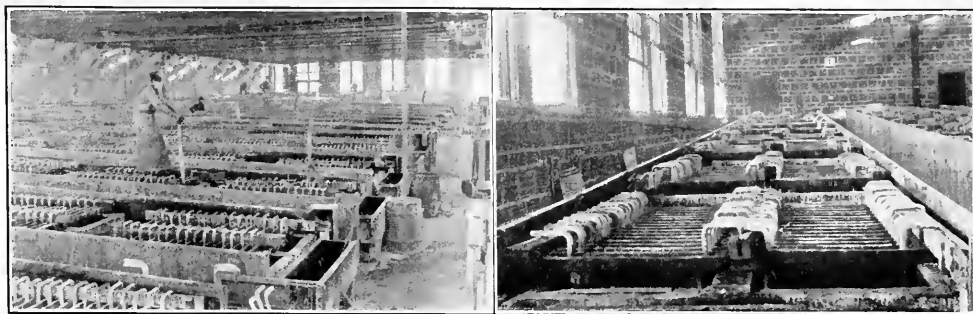
Stamp v. Ball-Mills

The Editor:

Sir—I have watched the discussion of this subject with much interest. There is one point that does not seem to me to have received sufficient attention. The only weak point about ball-mill operations in my experience is the wear of balls and lining. I have not seen any statement, in pounds, of the balls and lining consumed per ton of ore pulverized from a given size to a given mesh with the newer types of ball-mill such as the Marcy or some other modern ball-mill operated in closed circuit with a classifier and equipped with chrome-steel or manganese-steel lining, and where balls of an equally good quality were used. I had an extensive experience with an early design of central-discharge ball-tube mill 6 by 5½ ft., in which white iron linings and balls were used. The consumption of balls and linings was about four pounds per ton of hard flinty Republic quartz pulverized from ¾-in. size to about 20-mesh, when operated at a capacity of 100 tons daily. The mills of more recent design have developed a considerably higher capacity. A coarse feed from the rock-breaker—say, a 2½-in. size—undoubtedly reduces the wear of balls and lining, and the use of high-grade chrome or manganese-steel balls and linings will undoubtedly be helpful, but I have seen no data giving the exact wear of this better-grade material. Mr. Millikan once told me that in the dry-crushing ball-mills used at the Golden Cycle mill, where a good grade of imported manganese-steel ball was used, the consumption of balls was 0.7 lb. per ton. That would not be a bad showing in comparison with the average shoe-and-die consumption with stamps. There seems to be no longer any question but that the ball-mill has the better of the stamp on all other points. For a given tonnage it is very much more economical in first cost, cost of installation, floor-space, power, and simplicity of operation, and when running in close circuit with a classifier, it will do a wider range of work, and it can be manipulated so as to prepare any desired product. The only question is this: Is the consumption of balls and linings enough heavier than the wear of shoes and dies to make the old stamp battery or the combination of stamps followed by Chilean mill or pebble-mill more desirable in a remote district where the transportation of balls and lining would be both expensive and difficult? If the metallurgical department of the MINING AND SCIENTIFIC PRESS would collect the results of recent experience with different mills using the different types of ball-mills and varying grades and designs of lining, and varying grades and sizes of balls and the practice as to size of feed and mesh of finished product, it would perform an important service to the metallurgical profession.

ED. C. MORSE.

Dolom, Alaska, November 20.



TWO VIEWS OF THE INTERIOR OF THE ELECTROLYTIC ZINC DEPARTMENT.

Electrolytic Refining at Trail—II

By T. A. Rickard

ELECTROLYTIC PROCESS. The solution enters as a clear slightly amber liquid containing 6 to 8% zinc with 0.002% iron. The buss-bars from the generator-room, as they reach the 'tank' or electrolytic cell, are enclosed in cast-lead to protect them from corrosion. Each buss-bar is fused to the top of the cast-lead anode (30 by 25½ in. and ⅝ in. thick) to ensure perfect connection. The buss-bar connected with the cathode of the alternate cell consists of two copper plates that grip the cathode support, also of copper. The current passes from the lead anode into the solution, now properly called the 'electrolyte,' and thence to the cathode, which consists of a plate of aluminum, 24 by 27 in. and ⅛ in. thick. This is supported at one end by a copper lug, connecting with the buss-bar, while the other end has an iron bar or lug insulated by resting on a strip of wood lying on the lead of the buss-bar. The cells are in pairs. From the buss-bar along the central axis of one cell the current goes to the next cell. The voltage is 3 to 3.5. The consumption of electricity normally is 2.2 kw.-hr. per pound of spelter. The slight smell of acid recognizable in the building is caused by the bursting of bubbles of oxygen and hydrogen liberated by the electrolysis of water in the solution at the anode. When entering the room the solution has a temperature of 25 to 30°C. After repeated electrolysis it emerged at a temperature of 55° on the occasion of my visit; it is now kept down to about 35°C. The solution entered neutral, and issued with a 5 to 6% acidity. The electrolyte, as we have seen, becomes heated as it circulates through the cells; therefore an effort is made to cool it, especially in the lower cells, by inserting coils of lead pipe through which cold water flows. Fortunately, at this plant any quantity of pure cold water is available, so that this difficulty has been overcome satisfactorily.

The acid electrolyte, after leaving the cells, is returned by gravity to tanks in the leaching-room. From these tanks the solution is raised to another tank on a higher

level, where the acidity is increased to the required proportion by the addition of fresh acid through a pipe from the sulphuric acid plant.

This electrolytic plant then consisted of 14 sections of 32 cells each. The whole equipment has been doubled. Of the 14 sections, one is lined with lead and 13 are made of concrete, protected with P & B paint covered with asphalt. Each section produced 2½ to 3 tons of spelter per working day. In starting with new lead, the anode is coated with manganese dioxide, present in the solution and extracted from the ore itself, as explained to me by F. S. Willis, the superintendent of this department. The manganese coating renders the lead insoluble. Also it performs the highly important function of oxidizing the iron in the electrolyte from the ferrous to the ferric state, the latter being precipitated, while the oxygen from the decomposition of the zinc sulphate serves to re-oxidize the manganese, so that it is again ready to act as an oxidizer.

An electric crane runs above each series of cells, and at one side of the room a transfer-crane makes it possible to shift material from one series of cells to another or to the melting department. Porcelain insulators are placed along the sides and along the centres of the cells to support the buss-bars.

The cathodes are hung in cold water in order to remove any free acid, before stripping. The zinc deposited on the aluminum is detached in sheets by aid of a chisel-bar. Each sheet averages about 9 lb., so that 18 lb. is taken from a single cathode. The yield ranges from 5 to 40 lb. per cathode. These sheets are piled in 1000-lb. lots and taken by the crane to the melting-room. Thin sheets of zinc will take fire, or oxidize, before melting in a reverberatory furnace; therefore the fine stuff and scraps of cathode zinc are melted in graphite crucibles, placed in an oil-fired furnace, where the supply of air can be restricted. Metallic pots of any kind are objec-

tionable because the zinc is likely to absorb impurities from them. Hence a brick furnace is preferred. The cathode-sheets themselves are fed into a coal-fired reverberatory furnace, having a hearth 6 by 12 ft. and a 4-ft. fire-box. A brick ridge is built across the hearth to hold the dross back from the wall. The dross is removed by skimming through the charging-door once every 24 hours. The capacity of this furnace is 20 tons of metal. The melting is done in half an hour—the slower the better, as it hinders oxidation. Any oxide found in the furnace is returned to the acid solution and re-treated. The cathode-sheets yield 93% of spelter suitable for shipment. Eventually the missing 7% is recovered. It is a question whether to treat the dross (82% zinc) on the spot or send it to a zinc-retort smelter. At present it is being re-treated. The metal is sampled by boring a half-inch hole in every 50th bar or else the spelter is cut by a power-driven saw and the saw-dust used as a sample. On August 17 the plant produced 39,975 lb. of spelter, which was 99.801 fine, the impurities being 0.04 lead, 0.009 iron, and 0.15 cadmium. As the process is being developed and the difficulties surmounted, the impurities in the spelter are being further reduced. The production is now 70 tons per day.

COPPER. This electrolytic plant, at present, consists of 96 cells, each with a capacity of 10 tons of solution. Only the first half of the equipment was at work in August. The copper to be refined was cast direct from the converter, but the new melting-furnace, I am informed, is now finished. The cast anode in the electrolytic cell weighs 320 lb.; it remains in the cell until 92% of its weight has been dissolved by the acid solution, or electrolyte, which consists of 14% copper sulphate, 14% sulphuric acid, and 72% water. When the proportion of copper sulphate increases above the normal, the excess is removed by withdrawing a portion of the electrolyte (to evaporate it into crystals of bluestone), replacing it with fresh acid. The absence of effluvia and the freedom from gas are noteworthy in this plant. It has been modeled on the Walker design; indeed it was erected after consultation with him, Arthur L. Walker, professor of non-ferrous metallurgy in Columbia University.

The anode is suspended by two copper-wire loops, which are cast into the anode and enable it to hang from a round bar (also of copper), one end resting on the buss-bar, which transmits the electric current, while the other end rests upon an insulating block of wood*. I give these details for the sake of those unfamiliar with electrolytic practice.

Starting-sheets of hard (antimonial) lead, from St. Louis and having dimensions of 26½ by 41½ by ½ in., are being used just now, in lieu of the customary sheet of thin (¼ in.) copper. This, which constitutes the beginning of the cathode, is rivetted at the bottom between two horizontal copper bars (½ by 1 inch), so as to hang vertically in the solution. The copper precipi-

tated upon the lead cathode is stripped every day, yielding 5 to 8 lb. of copper on each face of the cathode. These sheets will serve as starting-sheets, on which the cathode copper will accumulate, to the weight of 150 lb., to be removed, washed, and melted subsequently, yielding metal 99.98 fine.

For the benefit of the unsophisticated, I may state that when an electric current is conducted through a solution, it decomposes that solution, causing a rearrangement of the molecules and a movement of particles called 'ions' in opposite directions. Some go with the positive electricity to the negative pole or 'electrode,' called the 'cathode,' while others go to the positive electrode, or 'anode.' The solution is called an 'electrolyte,' and the action is called 'electrolysis.' As Edgar A. Ashcroft says: "When electricity is passing through an electrolytic medium, disruption of chemical affinities is the result." To this I may add that the theory of electrolysis rests mainly on Faraday's idea of the actual dissociation (ionization) of the constituents of the electrolyte and his inference that the quantity of an element or 'ion' set free by a current of electricity is solely dependent on the amperes, or volume of current used, not the voltage.

The gold and silver together with other impurities in the anodes become concentrated in the slime that is deposited on the bottom of the cell as the anode is dissolved by the electrolyte. Likewise in the lead refinery, the precious metals pass into the slime. This slime, from both refineries, is collected and dried. The drying and roasting are done while the slime lies in a steel pan-car, exposed to the waste gases from the silver and doré furnaces. As soon as the drying is finished, the process of combustion is started by the oxidation of the antimony, also present in the slime.

This product is then melted, without flux, in a small reverberatory lined with magnesite brick. The antimonial slag is skimmed into a pot and 'hard lead' is eventually obtained from it. The copper rises next as an oxide slag and is skimmed. Then the doré metal (containing 970 parts gold and silver, predominantly the first) is ladled and cast into bars (each of 1000 to 1200 oz.) ready for parting. Two kettles each holding 7000 oz. are used. Sulphuric acid, 94% pure, is added and boiling is maintained for 8 hours. This puts the silver into solution as sulphate, the gold remaining as a granular powder, which is washed, dried, and melted into ingots. The silver solution is siphoned into two lead-lined tanks and boiled in the presence of copper plates, which precipitate the silver, while an equivalent amount of copper passes into solution as sulphate, which goes to the bluestone plant. I saw a car loaded with the 'cement' silver, washed from the copper on which it had been deposited, and noted that the surface of the silver had already been darkened by light from a window. The copper sulphate is pumped to another building, where it is evaporated to 45° B. and allowed to crystallize. This first and usually impure crystalline product is dissolved in boiling water; the resulting solution of copper sul-

*Mr. Hamilton informs me that this system was temporary. Anodes and cathodes provided with bugs are now being used.

phate is then placed in tanks in which are hung strips of lead upon which crystals of 'bluestone' are formed as the solution cools, the cooling being assisted by the injection of air. The bluestone is detached while the mother liquor drains back into the vat. Most of this bluestone is sold to farmers in Manitoba for killing 'smut' on wheat, and about two tons (out of the 88 tons made per month) is sold for use in the gravity-cells of telegraphic apparatus. Some of it is also sold to fruit-farmers to make the Bordeaux mixture, or spray, that kills the insect pests.

LEAD. In this plant I saw, first, the making of starting-sheets. The lead is melted in a kettle and is ladled into a 6-inch trough so as to pour or spread over an inclined steel plate, upon which the metal cools instantly, leaving a sheet of lead, $\frac{3}{8}$ inch thick, 39 by 27 in., the edges of which the operator trims with a knife and then peels off the steel plate. In 8 hours he makes 4000 sheets. These are taken into another room where they are smoothed and one end wrapped around a copper bar. Then the operator puts a band of paint at the solution-line of the lead sheet, so as to prevent it from being corroded by the electrolyte in the cell.

The cells, which are made of concrete, are 408 in number and have a total capacity of 100 tons of lead per day. The lead anode, cast at the blast-furnace, weighs 312 to 320 lb., and is reduced 80 to 85% before being re-melted. The starting-sheets have been described. Two cathode deposits are 'pulled,' or stripped, for each anode consumed. An average of 135 lb. is obtained at each stripping, or 270 lb. per cathode. The electrolyte in the lead cell contains 10% hydrofluosilicic acid (H_2SiF_6) and 5% lead fluosilicate ($PbSiF_6$) in water. The solution maintains its composition well, but there is a small loss and even a slight decomposition owing to chemical instability, so that fresh acid has to be added once per week. The lead does not accumulate in the electrolyte. Of course, this stability of the electrolyte is an important factor in the process, as it was explained to me by John F. Miller, the superintendent of this department.

The slime containing the precious metals that remains on the anode is washed off, collected, dried, and treated in the manner already described.

The electrolytic lead produced at Trail averaged in December, for example:

Gold	0.0027 oz. per ton
Silver	0.6126 " " "
Copper	0.0026%
Iron	0.0068%
Antimony	0.0075%

The electric current as received from Bonnington Falls has a voltage of 50,000, which is stepped-down to 2200 volts. The load at present is 8000 kw. So far the installation is for 15,000 kva., of which one-half is being used, but the plant will be doubled shortly to 30,000 kva. Now 13 or 14 sections of 3500 to 4000 amperes at 125 volts are being run. In the transformer-house there is a set of storage-batteries to operate the switches and also automatically to supply light to the electrical plant in

case of a break in the transmission-line. In the adjacent generator-room, 2300 volts is taken from the West Kootenay Power Co., the alternating current being converted into direct current by Westinghouse and General Electric generators of 500 kw. each, two generators in a set. Seven sets are in place. They deliver current at 125 volts. The saving of labor is noticeable in these direct-current installations: one man per shift of 8 hours, with another on day-shift to attend to repairs. Each unit is distinct, each motor and each generator being under separate control. The visitor is impressed by the quantity of copper used in these plants, especially in the form of buss-bars. The bright copper looks handsome; it is lacquered to prevent oxidation. The noise of the generators is due to the indrawing of the air for cooling, as explained to me by H. E. Large, representative of the General Electric Co. Seven generators at full load will give out 1200 hp. in heat-loss. This cannot be avoided; it is inherent in all electrical apparatus as used today. The temperature of the room was 114° F., when it was 92° outside, owing to the heat thus generated.

All the power-conductors are run underground in fibre conduits. The direct-current generators are provided with the commutating poles introduced eight or nine years ago. The equipment was supplied by the Canadian Westinghouse company at Hamilton and the Canadian General Electric at Peterboro, both of these manufactories being in Ontario. The power company sells electricity to the smelting company at the rate of $\frac{1}{2}$ cent per kw.-hour, which is equivalent to \$20 per hp.-year. At a consumption of 2.2 kw.-hours per pound of spelter, the power consumed in the process of electrolytic extraction represents a cost of 0.73c. per pound of metal.

The supply of cheap lead is a noteworthy factor at Trail. A lot of lead piping has to be used in making changes of one kind or another. The company uses its own lead, sending the scrap back to the refinery, so that none is wasted.

The equipment at Trail includes four Cottrell plants, which receive the waste-gases and dust from the lead blast-furnaces, the copper converters, the lead and zinc roasters, the D-L machine and the II & II pots. The Cottrell apparatus consists of steel tubes, 12 in. diam., in each of which hangs an iron chain charged with 80,000 volts. The effect of the electric current is to compel the deposition of the dust on the sides of the tube. As the dust adheres, it is loosened by blows of a hammer on the outside of the tubes. For those of less than 12-in. diameter, the speed of the furnace-gases must not exceed 3.6 ft. per second in order to ensure effective condensation of the fume. The lead blast-furnaces alone give about 160,000 cu. ft. of gas per minute. The sublimate is discharged into a hopper at the bottom of the tubes and is moved thence automatically by hoes, drags, or spiral conveyors to steel-plate cylindrical receivers, where it burns without the addition of any fuel. The fine sulphur, antimony, and carbon (from the coke) in the sublimate of fume all supply fuel sufficient to form an agglomerate suitable for blast-furnace smelting.

New Decrees in Mexico

During the last few months there have been issued several decrees by Carranza. These may be grouped under three main headings:

I. ACQUISITION OF NEW TITLES. In the case of all new denouncements, before title can be obtained it is necessary for the denouncer to sign a statement submitting himself to the same regulations as would apply to a national, in other words, to renounce his right to apply to his home government for redress should occasion for same arise.

Under normal conditions this law does not seem out of place, but in revolutionary times where revolutionists

collection of claims under one denouncement. Most large properties consist of several *fundos mineros*, and the decree is not clear whether each of these has to be worked or whether it be sufficient that a company operate its property as a whole. Technically, each *fundo minero* separately has to be worked, but it is inconceivable that this can be the meaning of the law.

II. PAYMENT OF WAGES. On October 23, 1916, a decree was issued requiring that all wages be paid on a basis of Mexican gold. A few days later this was interpreted by the Department of Fomento to the effect that the basis of wages should be that existing in 1912, but with the modification that an employee getting \$1.50 or more per day should be paid 50% of 1912 wages and one getting \$1.50 or less should be paid 60%. The rate



MEXICANS SORTING AND SACKING ORE AT EL ORO.

or the Government may seize property and work it for their own account, it would work a great hardship.

II. RETENTION OF TITLES. According to the old law in Mexico, title to mining property (*fundo minero*), was retained so long as taxes were paid. Now, according to a decree of September 11, to retain title all properties are required to commence operations before November 14, 1916, and, furthermore, they are subject to forfeiture should they desist operation for two consecutive months or a total of three months in one year.

On November 13, the operation of this law was postponed by another decree, for three months. Unless a further change is made, then, all properties in Mexico will have to be working by February 14, 1917. There are some districts in Mexico which are inaccessible owing to depredations of bandits; in such cases it is supposed that a special dispensation will be granted.

A technicality exists in this decree in that it states that all *fundos mineros* shall be obliged to work within a certain date, etc. Every mining property may consist of one or more *fundos mineros*, a *fundo minero* being a

of exchange on which these wages have to be paid is issued every ten days by the Department of Hacienda. This has received further modifications, the principal being that the Governor of each State shall decide for his particular State what basis of wages shall be paid. In Jalisco the Governor has decreed that 60% of wages shall be paid (giving another rate of exchange different from the Federal rate), except in the case of miners and farm-laborers, who shall receive the same wage as in 1912 without any reduction. Further dispositions have been made or arranged, whereby part of the money should be paid in silver or gold and part in paper, except in the case of mines, which have been ordered by the Governor to pay all wages in silver, though without any decree to this effect.

The net result of all these decrees and interpretations is that paper money no longer has any value in Mexico nor is it used, except in a few cases, such as for second-class fares on railroads. The last rate of exchange given by the Ministerio de Hacienda is 100 pesos paper for one peso Mexican gold.

Text of the Minerals Separation v. Hyde Decision

SUPREME COURT OF THE UNITED STATES

No. 46.—OCTOBER TERM, 1916.

Minerals Separation, Limited,
and Minerals Separation
American Syndicate, Lim-
ited,

vs.

James M. Hyde.

Certiorari to the United
States Circuit Court
of Appeals, Ninth
Circuit.

[December 11, 1916.]

Mr. Justice CLARKE delivered the opinion of the Court.

In this suit the complainants, the first named as the owner and the other as general licensee, claim an infringement of United States letters patent No. 835120, issued on the 6th day of November 1906, to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot. The usual injunction, accounting and damages are prayed for. The District Court sustained the patent as to claims numbered 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12; found that the defendant had infringed each of these claims, and granted the prayer of the petition. The Circuit Court of Appeals for the Ninth Circuit reversed the decree of the District Court and remanded the case with instructions to dismiss the bill. The case is here on writ of certiorari to review that decision.

As stated in the specification, the claimed discovery of the patent in the suit relates "to improvements in the process for the concentration of ores, the object being to separate metalliferous matter from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for such metalliferous matter over gangue."

The answer denies all of the allegations of the bill and avers that in twenty-five designated United States and five British patents the process described in suit was "fully and clearly described and claimed," and it also avers that the claimed discovery was invented, known and used by many persons long prior to the time when the application was made for the patent in suit. Notwithstanding this elaboration of denial counsel for the defendant in the summarized conclusion to their brief rely upon only five of the many patents referred to as showing that the patent in suit was anticipated and is therefore invalid for want of novelty and invention, viz: Everson (1886), Froment (Italy, 1902; Great Britain, 1903); Glagner (1903), Schwartz (applied for April 19, 1905, issued December 19, 1905), and Kirby (applied for October 17, 1903, issued December 18, 1906). And

the defendant, a man obviously experienced in the subject, says that, in his opinion, the whole basis of flotation concentration was disclosed in the Everson United States patent No. 348157 and in the Froment British patent.

It is clear that in the prior art, as it is developed in this record, it was well known that oil and oily substances had a selective affinity or attraction for, and would unite mechanically with, the minute particles of metal and metallic compounds found in crushed or powdered ores, but would not so unite with the quartz, or rocky non-metallic material, called "gangue." Haynes British patent (1860), and United States patents, Everson (1885), Robson (1897) and Elmore (1901). It was also well known that this selective property of oils and oily substances was increased when applied to some ores by the addition of a small amount of acid to the ore and water used in process of concentration. United States patents, Everson (1885), Elmore (1901), and Cattermole (1904).

Prior to the date of the patent in suit a number of patents had been granted in this and other countries for processes aiming to make practical use of this property of oil and of oil mixed with acid in the treatment of ores, all of which, speaking broadly, consisted in mixing finely crushed or powdered ore with water and oil, sometimes with acid added, and then in variously treating the mass—"the pulp"—thus formed so as to separate the oil, when it became impregnated or loaded with the metal and metal-bearing particles, from the valueless gangue. From the resulting concentrate the metals were recovered in various ways.

The processes, of this general character, described in the prior patents may be roughly divided into two classes. The process in the patents of the first class is called in the record the "Surface Flotation Process" and it depends for its usefulness on the oil used being sufficient to collect and hold in mechanical suspension the small particles of metal and metalliferous compounds and by its buoyancy to carry them to the surface of the mixture of ore, water and oil, thus making it possible, by methods familiar to persons skilled in the art, to float off the concentrate thus obtained into any desired receptacle. The waste material, or gangue, not being affected by the oil and being heavier than water sinks to the bottom of the containing vessel and may be disposed of as desired.

The process of the other class, called in the record the "Metal Sinking Process," reverses the action of the Surface Flotation Process and is illustrated by the Cattermole U. S. patent, No. 777273, in which oil is used to the extent of 1% to 6% to 10% of the weight of the

metalliferous mineral matter, depending on the character of the ore, for the purpose of agglomerating the oil-coated concentrate into granules heavier than water, so that they will sink to the bottom of the containing vessel, permitting the gangue to be carried away by an upward flowing stream of water.

The process of the patent in suit, as described and practiced, consists in the use of an amount of oil which is "critical," and minute as compared with the amount used in prior processes "amounting to a fraction of one per cent on the ore," and in so impregnating with air the mass of ore and water used, by agitation—"by beating air into the mass"—as to cause to rise to the surface of the mass, or pulp, a froth, peculiarly coherent and persistent in character, which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal and metalliferous particles of ore which were contained in the mass of crushed ore subjected to treatment. This froth can be removed and the metal recovered by processes with which the patent is not concerned.

It is obvious that the process of the patent in suit, as we have described it, is not of the Metal Sinking class, and while it may, in terms, be described as a Surface Flotation Process, yet it differs so essentially from all prior processes in its character, in its simplicity of operation and in the resulting concentration, that we are persuaded that it constitutes a new and patentable discovery.

The prior processes which we have described required the use of so much oil that they were too expensive to be used on lean ores, to which they were intended to have their chief application, and the efforts of investigators for several years prior to the discovery of the process in suit had been directed to the search for a means or method of reducing the amount of oil used, and it is clear from the record that approach was being made, slowly, but more and more nearly to the result which was reached by the patentees of the process in suit in March, 1905. The Froment Great Britain patent (1903) and the Kirby United States patent (applied for in 1903 and granted in 1906) are especially suggestive of the advance which was being made toward the desired result, but the Froment process was little more than a laboratory experiment and has never proved of value in practice, and the Kirby process, though approaching in some respects more nearly to the end attained by the process of the patent in suit, found its preferred application in the use of an amount of oil solution equal to one-fourth to three-fourths in weight of the ore treated, which was prohibitive in cost.

Into this field of investigation at this stage of its development came the patentees of the patent in suit. They were experienced metallurgists of London, of inventive genius and with financial resources, and they entered upon an investigation of the processes of oil concentration of ores which was continued through several years, and consisted of a very extended series of experiments in which the quantities of oil, of water and of

acid used and the extent and character of the agitation of the mass under treatment resorted to, were varied to an almost unparalleled extent as to each factor and the results were carefully tabulated and interpreted. It was while pursuing a comprehensive investigation of this character, having, as the evidence shows, the special purpose in mind at the time to trace the effect on the results of the process of a reduction to the vanishing point of the quantity of oil used, that the discovery embodied in the patent in suit was made. The experimenters were working on the Cattermole "Metal Sinking Process" as a basis when it was discovered that the granulation on which the process depended practically ceased when the oleic acid (oil) was reduced to about five per cent "on the ore." It was observed, however, that, as the amount of oleic acid was further reduced and the granulation diminished, there was an increase in the amount of "float froth," which collected on the surface of the mass and that the production of this froth reached its maximum when about one per cent or slightly less "on the ore" of oleic acid was used. This froth, on collection, was found to consist of air bubbles modified by the presence of the minute amount of oil used and holding in mechanical suspension between 70% and 80% of the total mineral content of the mass treated. It was promptly recognized by the patentees that this froth was not due to the liberation of gas in the mass treated by the action of the dilute acid used, and its formation was at once attributed in large part to the presence of the air introduced into the mixture by the agitation which had been resorted to to mix the oil with the particles of crushed ore, which air, in bubbles, attached itself to the mineral particles, slightly coated as they were with what was necessarily an infinitesimal amount of oil, and floated them to the surface. The extent of the agitation of the mass had been increased as the experiments proceeded until the "series of Gabbett mixers, fitted with the usual baffles, were speeded at from 1,000 to 1,100 revolutions per minute."

A careful consideration of the record in this case convinces us that the facts with respect to the process of the patent in suit are not overstated by the plaintiffs' witness, Adolph Liebmann, an expert of learning and experience, when he says in substance:

"The present invention differs essentially from all previous results. It is true that oil is one of the substances used but it is used in quantities much smaller than was ever heard of, and it produces a result never obtained, before. The minerals are obtained in a froth of a peculiar character, consisting of air bubbles which in their covering film have the minerals embedded in such manner that they form a complete surface all over the bubbles. A remarkable fact with regard to this froth is that, although the very light and easily destructible air bubbles are covered with a heavy mineral, yet the froth is stable and utterly different from any froth known before, being so permanent in character that I have personally seen it stand for twenty-four hours without any change having taken place. The simplicity

of the operation, as compared with the prior attempts, is startling. All that has to be done is to add a minute quantity of oil to the pulp to which acid may or may not be added, agitate for from two and one-half to ten minutes and then after a few seconds collect from the surface the froth which will contain a large percentage of the minerals present in the ore."

It is not necessary for us to go into a detailed examination of the process in suit to distinguish it from the processes of the patents relied on as anticipations, convinced as we are that the small amount of oil used makes it impossible that the lifting force which separates the metallic particles of the pulp from the other substances of it is not to be found principally in the buoyancy of the oil used, as was the case in prior processes, but that this force is to be found, chiefly, in the buoyancy of the air bubbles introduced into the mixture by an agitation greater than and different from that which had been resorted to before and that this advance on the prior art and the resulting froth concentrate so different from the product of other processes make of it a patentable discovery as new and original as it has proved useful and economical. It results without more discussion, that we fully agree with the decision of the House of Lords, arrived at upon a different record and with different witnesses, but when dealing with the equivalent of the patent in suit, in *Minerals Separation, Limited, v. British Air Concentration Syndicate, Limited*, 27 R. P. C. 33. In this decision Lord Shaw, speaking for the court and distinguishing the process there in suit especially from the Elmore oil flotation process which had gone before but which was typical of the then prior art said: "They (the patentees of the Agitation Froth Process of the patent in suit) are not promoting a method of separation which had before been described, but they are engaged upon a new method of separation. Instead of relying upon the lesser specific gravity of oil in bulk they rely upon the production of a froth by means of the minute quantities of oil reaching the minute particles of metal, but forms a multitude of air cells, the buoyancy of which air cells, forming around single particles of the metal, floats them to the surface of the liquid."

And Lord Atkinson said: "In their process this mysterious affinity of oil for the metallic particles of the ore is availed of, yet the oil is used in such relatively infinitesimal quantities, that the metallic particles are only coated with a thin film of it, and the lifting force is found not in the natural buoyancy of the mass of added oil, but in the buoyancy of air bubbles, which, introduced into the mixture by the more or less violent agitation of it, envelop or become attached to, the thinly oiled metallic particles, and raise them to the surface, where they are maintained by what is styled the surface tension of the water."

The record shows not only that the process in suit was promptly considered by the patentees as an original and important discovery, but that it was immediately generally accepted as so great an advance over any process

known before that, without puffing or other business exploitation, it promptly came into extensive use for the concentration of ores in most, if not all, of the principal mining countries of the world, notably in the United States, Australia, Sweden, Chile and Cuba, and that, because of its economy and simplicity, it has largely replaced all earlier processes. This, of itself, is persuasive evidence of that invention which it is the purpose of the patent laws to reward and protect. *Diamond Rubber Co. v. Consolidated Tire Co.*, 220 U. S. 428; *Carnegie Steel Co. v. Cambria Iron Co.*, 185, U. S. 403, 429, 430; *The Barbed Wire Patent*, 143 U. S. 275; *Smith v. Good-year Dental Vulcanite Co.*, 93 U. S. 486.

The claim that the patentees of the patent in suit are not the original discoverers of the process patented because an employee of theirs happened to make the analyses and observations which resulted immediately in the discovery, cannot be allowed. The record shows very clearly that the patentees planned the experiments in progress when the discovery was made; that they directed the investigations day by day, conducting them in large part personally and that they interpreted the results. *Agawam Company v. Jordan*, 7 Wall. 583-603, rules this claim against the defendant.

Equally untenable is the claim that the patent is invalid for the reason that the evidence shows that when different ores are treated preliminary tests must be made to determine the amount of oil and the extent of agitation necessary in order to obtain the best results. Such variation of treatment must be within the scope of the claims, and the certainty which the law requires in patents is not greater than is reasonable, having regard to their subject matter. The composition of ores varies infinitely, each one presenting its special problem, and it is obviously impossible to specify in a patent the precise treatment which would be most successful and economical in each case. The process is one for dealing with a large class of substances and the range of treatment within the terms of the claims, while leaving something to the skill of persons applying the invention, is clearly sufficiently definite to guide those skilled in the art to its successful application, as the evidence abundantly shows. This satisfies the law. *Mowry v. Whitney*, 14 Wall. 620; *Ives v. Hamilton*, 92 U. S. 426, and *Carnegie Steel Co. v. Cambria Iron Co.*, 185 U. S. 403, 436, 437.

The evidence of infringement is clear.

While we thus find in favor of the validity of the patent, we cannot agree with the District Court in regarding it valid as to all of the claims in suit. As we have pointed out in this opinion there were many investigators at work in this field to which the process in suit relates when the patentees came into it, and it was while engaged in study of prior kindred processes that their discovery was made. While the evidence in the case makes it clear that they discovered the final step which converted experiment into solution, "turned failure into success," (*The Barbed Wire Patent*, 143 U. S. 275), yet the investigations preceding were so informing that this final step was not a long one and the patent must be con-

fined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as "critical proportions" "amounting to a fraction of one per cent on the ore," and therefore the decree of this court will be that the patent is valid as to claims No. 1, 2, 3, 5, 6, 7 and 12, and that the defendant infringed these claims, but that it is invalid as to claims 9, 10 and 11. Claims No. 4, 8 and 13 were

not considered in the decrees of the two lower courts and are not in issue in this proceeding.

The decision of the Circuit Court of Appeals will be reversed, and the decision of the District Court modified to conform to the conclusions expressed in this opinion, will be affirmed.

A true copy.

Test: Clerk Supreme Court, U. S.

Accidents in California

The Industrial Accident Commission of California reports that for the year ended June 30, 1916, there were 533 deaths, 1264 permanent injuries, and 65,741 temporary injuries. There was a reduction of 158 deaths compared with 1914-'15. There were also 28 less permanent injuries, but 5500 more temporary injuries. The latter is accounted for by the growth of industry. There are nearly 1,000,000 wage-earners in the State. The compensation paid to injured workers or their dependents for 67,538 injuries was \$1,150,504. The medical cost was \$852,202. The wage-loss created by industrial injury was close to \$18,250,000. Over 90% of the compensable injuries are not disputed. The average number of days between medical examinations and decisions was 29.31 days. More and more as time goes on it has been found advantageous to rate permanent injuries on the loss of earning power, based on the nature of injury or disfigurement, the occupation, and the age.

The income of the State Compensation Insurance Fund to June 30, 1916, had reached \$1,837,761. Expenditures and reserves amounted to \$1,161,315. Refunds to policyholders have been paid to the extent of \$134,382, leaving a net surplus of admitted assets over liabilities of \$242,063. The dividends declared have amounted to 15% of the premiums earned during the years 1914 and 1915. The total will probably exceed \$170,000 when pay-rolls of all insured employers have been ascertained. The actual refunds do not constitute the entire saving to patrons, but really represent a saving in operating cost only. The total average expense-ratio is 14.17%, or less than half that of insurance corporations.

The general safety orders for California's industries became effective on January 1, 1916. The mine-safety rules became effective on the same date. These were compiled by a committee of operators and miners, in conjunction with the mining engineer who heads the mining department under the co-operative agreement in effect between the U. S. Bureau of Mines and the Industrial Accident Commission. There was started a safety campaign among those engaged in California's mining industry. A total of 355 mines, quarries, and dredges was inspected. Training in first aid to the injured was given to 711 miners. The interest of miners was enlisted in safety by the formation of the Miner's Safety Bear Club. More than 5000 miners are on the membership roll. This club is unique in that it has no dues and each member receives a safety-bear button and safety literature contributed by the State through the Commission.

Court Decisions on Compensation

The most important decision of the Supreme Court was rendered in the case of the Western Indemnity Co. v. Industrial Accident Commission of California (151 Pac. 398), when a divided Court found full sanction for the statute in the police power and in the right and power of the Legislature to classify occupations for the purpose of this kind of legislation.

In the case of the Western Metal Supply Co. v. Industrial Accident Commission (51 Cal. Dec. 447) a divided Court upheld the validity of the extension of the Act by the Legislature to cover death benefits to dependents of workmen fatally injured, and upheld its further extension for the benefit of alien dependents.

The Supreme Court leans strongly toward the position that the Industrial Accident Commission is "in legal effect" a court, because it is invested with many of the formal functions of a judicial tribunal. It is asserted by the Commission that compensation, insurance, and safety are so intimately related and interwoven as parts of an adequate compensation system, as to require intimate knowledge and close contact with all three departments.

Wilful misconduct has been broadly constructed in the Commission's decisions. The Courts have taken a narrower view and have annulled several awards.

In the case of the North Alaska Salmon Co. v. Pillsbury *et al.* (51 Cal. Dec. 473) the Commission's award was affirmed that the compensation statute extends to cover injuries and deaths suffered by employees without the physical boundaries of the State, where the contract of hire is made within the State and the employee is a resident of the State. A petition for re-hearing was granted.

BLAST-HOLE MACHINES, as they are called, are drilling-machines of the Keystone type, used to drill holes 6 in. diameter and 35 to 10 ft. deep for the purpose of blasting down a large amount of ore or waste in advance of the steam-shovels. They are used in all of the great excavations of the disseminated-copper deposits. The holes are usually drilled about 20 ft. back from the edge of the terrace, or face, on which work is progressing. Several holes are drilled at intervals of 20 or 25 ft. and these are "sprung" several times and then charged heavily for the final blast. Where conditions are favorable thousands of tons of rock, or ore, are thrown down in a single series of blasts prepared in this manner.

Manganese in West-Central Arkansas

By Garnett A. Joslin

Knowledge of the presence of manganese in the Ouachita mountains of west-central Arkansas antedates the Civil War, yet, until the present summer, there has been no active interest in the deposits. Some desultory prospecting was done years ago, under the impression that the psilomelane was an ore of gold, but the holes have long since caved and the prospectors vanished. Later, when the ore was identified, the demand for manganese offered no incentive for prospecting a field so inaccessible. Railroads were far away and the few roads were bad. A report by Penrose,* published by the Geological Survey of Arkansas in 1890, and later the comments of Harder,† in a bulletin of the U. S. Geological Survey, offered little encouragement to the prospector. Now, with railroads nearer and wagon-roads in better condition, the higher price for the ore has stimulated prospecting and it is probable the present year will determine whether the district can profitably produce manganese ore.

The manganese belt of west-central Arkansas extends from Polk county, on the west, in an easterly direction to Pulaski county on the east. The part of the belt to be described consists of those portions of Pike, Montgomery, and Polk counties that lie in the Ouachita mountains. The Ouachita mountains extend south of the Arkansas river in an east-west chain, and form a prominent feature of the topography. Structurally, the system is an anticlinorium characterized by many sharp ridges that rise 500 to 1000 ft. above the intervening valleys, or to altitudes of 1500 to 2000 ft. above sea-level. These anticlinal ridges are formed of steeply-dipping beds, are roughly parallel, and trend east-west; the anticlinorium having been formed by thrust-pressure from the north and south. The rocks are sedimentary, comprising sandstone, chert, shale, and novaculite. Erosion has accentuated the steep slope of the ridges by cutting into the softer sandstones and shales, forming streambeds and leaving sharp crests of the novaculite and the harder sandstone. Water-gaps cut the ridges in a north-south direction at frequent intervals.

The rocks of economic interest are the shale and the novaculite. Novaculite (razor-stone) is a sedimentary rock resembling dense fine-grained quartzite, and was long thought to be quartzite, having been described by Kemp as "a silicious ooze." Whether this term suggests the correct genesis is open to question, but as a lever to dislodge the name "quartzite" from the mind it is admirable. Manganese ore occurs in the lower part of the novaculite bed and in its upper portion with the overlying shale. It forms discontinuous lenses, which follow bedding-planes, frequently widening to fill joint-cracks and form local segregations at the junction of bedding-

plane and joint-crack. It also occurs as a manganese cement in a novaculite-breccia. In general the ore is a blue-black psilomelane, commonly botryoidal, containing occasional pockets of pyrolusite in soft earthy masses. In intimate association with the manganese are ores of iron that vary from black botryoidal hydrated oxides to the familiar 'brown ores.' They occur in the same lens, either with the manganese or wholly displacing it, and in separate bedding-planes. In prospecting the iron is considered a good lead to manganese.

Successive outcrops of an ore-bearing horizon in the novaculite may be traced for miles. It is this general east-west continuity, together with the frequent repetition of the outcrops in a north-south direction—due to the close folding that causes the beds to rise and plunge alternately—that causes prospectors to believe in a system of parallel 'fissure-veins,' while the native mountaineers hold that there are "mountains of ore."

In this connection, and in speculating on the depth to which the manganese may go, the origin of the ore should be considered. Such evidence as has been gathered points to a theory similar to that advanced by Harder‡ for the origin of the manganese ore of the Appalachian region, which appears to apply to that of the Ouachita mountains. The rocks from which the novaculite was derived contained manganese minerals that were deposited with the sediments. After emergence from the sea, erosion began, the manganese was dissolved, precipitated and concentrated by percolating waters along favorable bedding-planes and joint-cracks in what are now the lower manganese horizon and the upper portion of the novaculite beds. If this theory is correct, it follows that there will be no marked persistence of ore below the ground-water level.

Methods of prospecting so far developed are both good and bad. Individuals and groups of men who have staked claims, or own land upon which manganese occurs, men who have little money to spare and must therefore make their work pay for itself, are forced to follow that golden rule: "Follow the ore." Several shafts now being sunk, in the belief that the richer ore is deeper may throw some light upon the depth to which profitable ore may be expected. In general the prospectors and miners who cannot afford to pay for the advice of a mining engineer are following the usual methods. In one instance a cross-cut adit is being driven to cut a lode that outcrops on the hillside several hundred feet above the 'tunnel' mouth, in the belief that the lode is vertical. A brief study of the structure would have shown that the direction of dip of the ore-horizon at this place is the same as the line of the adit. The lure of the cheap operating cost of the cross-adit still hovers over undeveloped prospects. With a little more attention to geological

*R. A. F. Penrose, Jr., Ark. Geol. Surv., vol. 1, 1893.

†Edmund Cecil Harder, U. S. G. S. Bull. 427, 1910.

‡U. S. G. S. Bull. 427, pp. 99-100.

structure and some serious speculation over the origin of the ore, more would be learned about the deposits.

Harder in his report discouraged prospecting when he stated that widths of over a foot were rare. At the present time there are several prospects that show a width of three feet and over of solid psilomelane. Several carloads of ore have been shipped. It is reported that this ore gave returns of 50 to 60% manganese. This seems to be the average for the sorted ore of the region. Silica sometimes mounts to 8% and the phosphorous content is usually about 0.2%. There is a fair chance that somewhere in this region a profitable mine will be developed.

Mining conditions are good. Water is abundant and the hills are covered with pine and oak. The climate is favorable. It is estimated that roads suitable for motor-truck haulage can be built connecting with railroad-points at a moderate cost per mile. Labor is cheap, the prevailing wage being \$1.50 per day and board, but as might be expected, it is inexperienced and erratic. The mountaineer is illiterate and none too fond of work. He is prone to light a ten-minute fuse and then run a quarter of a mile at top speed. He has much respect for dynamite and very little for 'moonshine.' So far the supply of men has been ample for all operators and the 'cost of firing' may be considered as negligible.

Nitrates in the United States

Nitrate deposits in many parts of this country have been examined during the last two years by the U. S. Geological Survey. The importance of finding a natural supply of nitrates within our own borders, which might serve our needs in case of war, has given incentive to this work, and has directed widespread public attention to the subject.

Prospectors in many places have raised great hopes by finding good surface-showings of these salts, but investigation has seemed to force the acceptance of a general adverse judgment as to their value—a judgment that has been adopted with the greatest reluctance by all concerned. Incidentally, advantage seems to have been taken of the situation to promote certain share-selling enterprises, even after the evidence as to the worthlessness of the deposits became sufficient to satisfy any competent judge, so that one is forced to question either the good faith of the promoters or their practical judgment. As a result of careful study of these deposits, and particularly of evidence gathered on recent visits to prospects in different parts of the country, Hoyt S. Gale, a geologist of the Survey, has submitted the following general summary, which is commended to the consideration of those tempted to invest their money in such enterprises.

Fine specimens of practically pure nitrate of soda and nitrate of potash—saltpeter—have been found in many parts of the country, and careful investigation of specimens and localities seems to warrant some definite conclusions as to the practical value of these deposits, especially to those who are invited to spend their money in investigations like those the Survey has already made. The nitrate salts occur as crusts or films on the faces of ledges; as seams—most of them thin, though some are fairly thick—in crevices of shattered rock; and as deposits filling spaces in porous rocks at and near the surface or extending to a depth of several feet. They are naturally preserved in recesses in the rock ledges, where they are sheltered from the dissolving action of rain, snow-water, or even mist. They are found in lava ledges, in beds of volcanic tuff or ash, and in limestone and sandstone. Their existence or preservation is apparently

dependent rather on the shattered or porous nature of the rock than on its kind or composition. These deposits, which have been referred to as cave or ledge deposits, are of essentially the same type wherever found, although they vary considerably in details of occurrence. The incrustations are found not only on the faces and fractures of ledges of solid rock, but some of them form layers or cementing constituents in the loose soil and rock-breccia at the bases of cliffs, or lie in places protected from the weather. Some samples obtained from both these sources are rich in nitrate salts, and analyses of such materials will bear little significant relation to the actual character or content of the mass of the rock of which the ledge is formed. It appears that the deposits are surficial—that is, they do not extend far into the mass of the rock—and the nitrate salt found is insignificant in amount. Nitrates are found in unusually large quantities in some soils and in some clay hills, particularly in southern California. These deposits have been examined by many persons and the general conclusion reached has been unfavorable to the idea of their practical utilization. The nitrate content, although unusually large as compared with the content of ordinary soils, probably does not average over 1 or 2% of the soil or clay, and it is doubtful whether the material could be worked commercially.

Any one who is not convinced by the judgment already reached as to these deposits, and who is determined to devote his time or money to their further exploration, should do so with full knowledge of the evidence already in hand and should not be led into such a venture by more or less misleading representations. The Survey will always be glad to make an examination of any samples submitted.

The Aluminum Ore Co., a subsidiary of the Aluminum Co. of America, of Pittsburgh, has bought 200 acres at Sellers Point, Md., where a plant will be built to manufacture aluminum from bauxite. The capacity of this new plant will be less than the company's plant at East St. Louis, but is so planned that extensions can be made as needed. It will cost about \$1,000,000 and is expected to be ready for operation early in 1918.

Matte Granulation at Herculaneum, Missouri

By S. Paul Lindan and Henry B. Smith

*Three years ago it was decided by the management to granulate the matte produced in the smelter of the St. Joseph Lead Co. at Herculaneum, thereby doing away with a large amount of labor in handling the matte and in subsequent crushing. On March 1, 1915, the granulator was put in operation and up to January 1, 1916, 18,735 tons had been granulated. The four blast-furnaces have a daily output of about 280 tons of pig-lead and 100 tons of matte assaying about 11% lead. It is expected that projected improvements in roasting methods will eliminate more sulphur from the charge, and cut down the matte-fall to about one-half of the present figure.

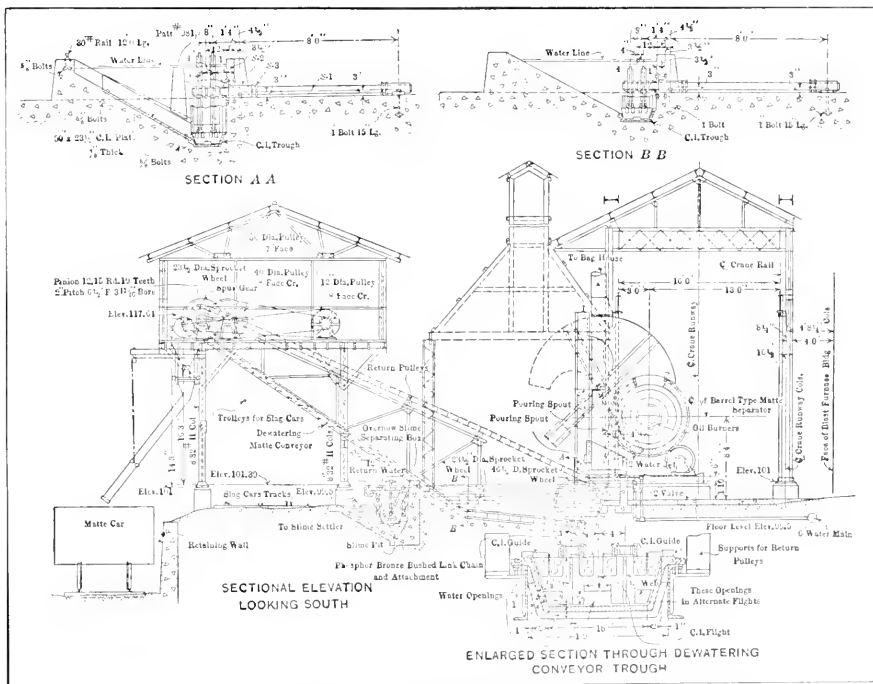
The blast-furnaces are tapped into movable fore-bearths or settlers, 6 ft. by 4 ft. by 22 in., the slag overflowing into 27-cu. ft. slag-cars that are hauled to the dump by electric locomotives.

Under the present plan of granulating, the matte is tapped into 6-cu. ft. iron ladles. These are transported

*Abstract from paper to be read before the American Institute of Mining Engineers New York meeting, February 1917.

to the granulating-plant by a 5-ton overhead electric traveling-crane, the runway of which extends the full length of the blast-furnace building. A cylindrical container receives the matte from the ladles. This container is a specially designed Traylor copper-converter minus the tuyeres and with a 20-in. opening at one end for the flue and oil-burners. It measures 77 by 120 in. inside, is lined with magnesite brick 9 in. thick and can be tilted by means of a 50-hp. motor. A steel flue 18 in. diameter, leading from one end, conducts any fume to the bag-house. Just under this flue are placed two oil-burners for heating. Generally one is found sufficient to keep the matte in a molten state. The consumption of 18 to 20° B. crude oil is 250 gal. per 24 hr., or 2 to 2½ gal. of oil per ton of matte granulated. Air at 30 lb. pressure is supplied to the burners for atomizing the oil.

The granulation is accomplished by pouring the molten matte through two superimposed flat jets of water shooting horizontally into a concrete tank lined with cast-iron plates. The stream of matte is disintegrated into small shot-like particles before reaching the body of



MATTE GRANULATING PLANT OF THE ST. JOSEPH LEAD CO. AT HERCULANEUM, MISSOURI

water. The stream of molten matte is accurately directed on the jets of water by a so-called pouring-box, the spout of which is 6 in. above and 12 in. in front of the upper nozzle. This box is lined with common brick and the matte is poured directly into it by revolving the container. The pour-holes are slots 2 in. wide by 8 in. high.

A dewatering drag-conveyor removes the granulated particles of matte from the tank. The floor of the tank slopes down to the trough in which the conveyor operates, at an angle of about 30° . It is placed to one side, out of the line of the streams from the nozzles. It elevates the matte over the slag-track and discharges into standard-gauge railroad cars, which are weighed, and their contents sampled and emptied into the roaster-bins. In the end of the concrete tank opposite the nozzles, a V-shaped settling-box takes the overflow water. This box prevents the loss of the coarser slime, while the finer material settles out in a series of settling-tanks, one overflowing into the other. An excelsior filter finally clears the water before it enters the circulating pond. There are two series of settling-tanks, one in use while the other is being cleaned out.

The matte in the cylindrical container is kept fluid by one or both of the two oil-burners before mentioned. The burners are placed so that the flame shoots slightly upward in the container. An oxidizing flame is used, though there would be some practical advantages if a reducing flame could be employed. It was found impossible, however, to maintain the required temperature with a reducing flame. If the matte remains in the container too long, an oxidized scum is formed which interferes with the pouring.

The matte is discharged from the barrel container through an opening in the side, 2 by 8 in., provided with a spout delivering into the pouring-box which rests on the concrete wall of the tank directly over the water-nozzles. This pouring-box is made of sheet-iron and is lined with common firebrick; inside dimensions are 18 in. by 18 in. by 3 ft. The matte tends to chill and build up in the box, but a narrow passage about 3 in. wide is easily maintained along the path of the stream. This box in turn discharges through an opening 2 by 8 in., the matte being directed by a cast-iron spout so that it meets the horizontal jets of water at an angle of 70° to 80° . All the matte should be broken up and be pre-chilled before striking the main body of water. As a rule the stream of matte is broken up by striking the upper jet while the lower jet insures further cooling. It was found that if some of the matte missed the jets or if the rate of pouring was too rapid, thus preventing the thorough pre-chilling of the matte, some of the semi-molten particles united again into large lumps, frequently causing explosions in the tank. Likewise, too rapid pouring will promote the formation of large granules up to an inch in diameter, which are detrimental to good roasting. Too slow pouring allows the matte to chill before leaving the pouring box, thereby causing the opening in the spout to freeze gradually. The right speed was obtained after a little experimentation. A stream

of matte as large as $2\frac{1}{2}$ in. diam. where it strikes the jets has been granulated satisfactorily. A hot matte makes a better product for roasting, because it is more uniform and finer. A good product is that of which 75% passes a $\frac{1}{16}$ -in. screen. The average rate of pouring is 3.2 cu. ft. of matte per minute.

The water-jets are delivered through rectangular nozzles, the openings being $\frac{3}{4}$ by $3\frac{1}{4}$ in. with the nozzles 5 in. apart. The supply of water is 100 gal. per min. under a head of 40 ft. The granulating-tank is constructed of concrete, 17 ft. long and $7\frac{1}{2}$ ft. wide, the floor being plated with 1-in. cast-iron plates, at a 30° slope into the conveyor-trough. This degree of slope has been found sufficient to cause the granulated particles to run into this trough. The drag-conveyor is driven by a 10-hp. motor at a speed of 30 ft. per min. and runs in a sectional cast-iron trough 4 in. deep and 15 in. wide. A small amount of water, about 5%, passes over with the matte into the railroad-cars, drainage being assisted by notching the conveyor-flights alternately in the centre and on the ends, thus allowing the entrained water to escape and flow back into the tank. The tail-sprocket wheel and the idler-sprocket wheel are both under water. The shafts of these wheels extend through stuffing boxes in the sides of the tank, to the bearings on the outside.

Some lead settles out of the matte while in the container, about 30 to 60 pigs of 65 lb. each, according to the condition of the furnaces, being poured out daily. In case lead goes over and is granulated with the matte, it manifests itself by a sputtering and popping on the surface of the water. After the matte has been poured down to the lead-level, the operator turns the container backward and pours the lead into a ladle, whence it is molded into pigs.

To prevent metal losses, the fumes are caught by a swinging hood that fits over the charge-opening and connects with the blast-furnace flue leading to the bag-house. The hood may be swung back so as to uncover the charge-opening, when the crane is ready to pour a ladle of matte into the barrel-container.

This installation requires only two men per shift for operation, one to operate the container and one the crane. The forehearth tappers at the furnaces attach the crane-hook to the ladles. Under the old method of handling the matte by hand-pots, the cost was \$7c. per ton, which included hand-breaking. Crushing and screening amounted to 56c. per ton in addition, which brought the total cost to \$1.43 per ton. Granulation costs only 75c. per ton, which makes the total saving of $\$1.43 - 0.75 = \0.68 per ton of matte granulated.

SOME of the large more progressive manufacturers of the East are seriously considering the adoption of the metric system of weights and measures, and to this end enquiry is being made by the Philadelphia Bourse to ascertain to what extent the French system can be readily adopted in catering to the large and rapidly increasing foreign trade.

Counter-Current Decantation

By L. B. Eames

*The recovery of dissolved gold from pulp in cyanide-plants was first accomplished by intermittent decantation. This simple process consists in mixing with the pulp, containing the metal in solution, a solution of lower gold-content, settling the mixture in a tank, and decanting the clear supernatant liquor. The thick pulp remaining in the tank is pumped to a second tank, together with more barren solution, and again settled and decanted. After several repetitions of this operation, the value is so far reduced that further washing is not profitable. Gold extraction by this process is high, but the plant required is extensive, labor cost is high, and the amount of solution to be precipitated is excessive.

In 1901, John Randall employed the same principle in cones, instead of flat-bottomed tanks, which operated continuously, discharging a regular stream of thickened pulp. These cones were operated in series, the thick under-flow of the first one forming, with a stream of diluting solution, the feed to the second cone of the series. Barren solution was added to the tank immediately preceding the discharge-tank and, after being slightly enriched by the low-grade pulp in this tank, overflowed to form a diluting solution again for the richer feed entering the third tank from the end of the series, and so on back to the richest tank of the series. Clear water was used for the wash in the final tank. This is the principle on which all successful counter-current decantation plants operate at the present time, but Randall's plant was not successful because of mechanical difficulties in getting a continuous thick discharge from his cone-tanks.

In 1910, two decantation plants were built making use of flow-sheets similar to that used by Randall 9 years before, but substituting Dorr thickeners for the cones. One of these was at Moerito in Sinaloa, Mexico, and was installed under the direction of C. Dupre Smith; while the other was designed by J. V. N. Dorr, assisted by the writer, for the Vulture Mines Co. of Wickenburg, Arizona. While perhaps not perfect at first, both of these pioneer plants were so successful as to encourage further installations, which have increased considerably during the past three years.

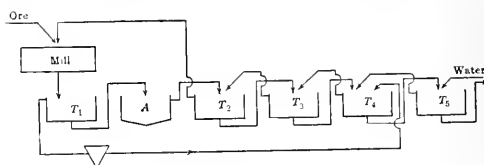
The accompanying sketch is a simple yet typical flow-sheet of the C.C.D. system. It is assumed that crushing is done in cyanide solution, the overflow from the tank T_2 being used for the crushing-solution. This solution leaves the grinding-circuit with the ground pulp and enters T_1 , and that part which does not pass to the agitators with the pulp overflows T_1 , and goes to precipitation. After depositing its gold-content, it is used to dilute the underflow of T_1 as it enters T_2 . The overflow of T_2 is also mixed into the feed to T_3 . The overflow of T_3 mixes with the underflow of T_2 to form the feed

to T_4 , and so forth, as indicated in the flow-sheet. At each succeeding mixture the solution meets a pulp of higher dissolved metal-content than itself, and is enriched while the pulp is correspondingly impoverished. The pulp at each step approaches the discharge-end of the mill while the solution goes to the feed end—hence counter-current decantation.

The principal factors that may affect the efficiency of the process are: (1) grade of ore; (2) ratio of solution precipitated to ore treated; (3) thickness at which pulp can be discharged; (4) cost of chemicals; (5) rapidity of dissolving, and the place in the circuit where it takes place; and (6) efficiency of precipitation.

Since the process is one involving volumes and dilutions, it is possible to calculate accurately what distribution of metal-content should take place under any given set of conditions. As far as possible, each one of the above variables has been mathematically considered independently of the rest and the results have been plotted. [In the PRESS of August 28, 1915, these calculations were given in full, when the Rochester Mines Co.'s mill was described.—EDITOR.]

Any considerable dissolving during decantation will



FLOW-SHEET OF C.C.D. PLANT.

be indicated by a difference in the assay-value of the solution in the under-flow of the tanks as compared with the over-flowing solution. In practice there is always more gold per ton in the under-flow solution than in the over-flow of any given tank, but in the ores of Porcupine district, Ontario, this difference is very small. Other causes may, and no doubt do, tend to produce this difference between the over-flow and the under-flowing solution. Adsorption is probably the most important and perhaps the least understood of these. In the case of Porcupine ores this phenomenon is of small importance, as the ore is composed of crystalline schist and quartz, and there is little tendency for the ore to flocculate under the influence of the solutions used. The gold and silver ores of the Western States are in many cases in eruptive rocks; these ores usually flocculate in solution, and in doing so seem to entrap a portion of the metal in solution. At any rate there is a much more noticeable difference in the assays of tank effluents in the treatment of these ores. This has in some cases been blamed on faulty mixing of the products fed to the tank.

Proper precipitation is essential in decantation, as the amount of dissolved gold lost is in proportion to the value of the barren solution used.

At the Hollinger mill at Porcupine, the decantation plant at present consists of five rows of 40-ft. tanks, four tanks to a row, forming a plant of five units. The

*Abstract from paper prepared for New York meeting of American Institute of Mining Engineers.

tanks are arranged with a difference in elevation of 2 ft. 6 in. between steps, with the final tanks of the series the highest, so that all solutions pass through and out of the plant to precipitation. The diaphragm-pumps used were designed by the company's staff, and have been reliable and economical. They are all three-throw or triplex pumps, so that in spite of the large tonnage handled, the duty on each diaphragm is light. The barren solution and water-wash added to each row are measured by separate float-reading weir-boxes assuring uniform results from the various units. Only one man is necessary for each shift. Power consumed by each tank is under one horse-power, while each pump uses about the

same. The cost of decanting is 2.09c. per ton. The recovery is almost the theoretical maximum. The following table gives results covering a period during which 38,885 tons of \$8.92 ore was treated:

Ratio of ore to solution precipitated.....	100 to 285
Solution precipitated, tons.....	110,604
Strength of cyanide used.....	0.9 lb. per ton, or 0.0045%
Cyanide added per ton of ore, pounds.....	0.46
Difference between pulp-feed and pulp-discharge for first tank after agitators, cents.....	25
Average moisture in tailing, per cent.....	45
Average value of barren solution, cents.....	3.2
Dissolved gold per ton of solution discharged, cents.....	11.71
Dissolved gold per ton of ore discharged, cents.....	9.57

A Discovery of Celestite

By Willard Mallory

Four miles north-east of Lavic station, on the Santa Fe railroad, in San Bernardino county, California, is a large deposit of celestite, the white outcrops of which are plainly visible from the railroad, which at its nearest point is two and one-half miles south.

These outcrops have been examined by prospectors many times, but only recently has the real character of the mineral in them been determined. The deposit is in a stratified formation with an easterly strike and a steep dip to the south. It lies along the southern base of a mountain composed of Tertiary volcanic rocks and occupies a tilted position in normal relation to this mountain uplift.

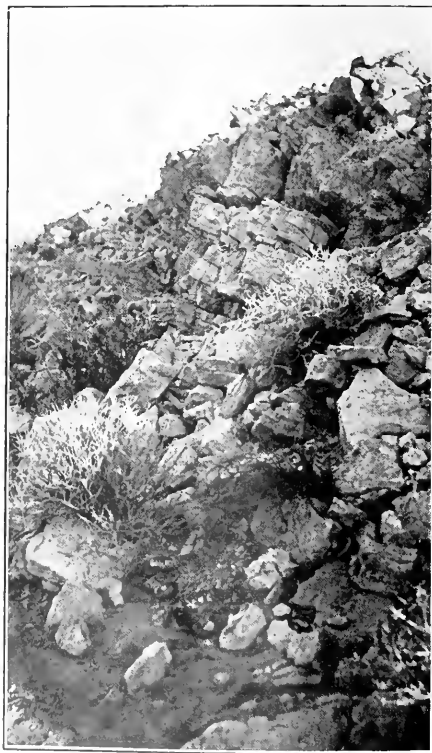
This formation has an average width of 100 ft. for a length of 2000 ft. To the east it narrows rapidly in width and finally gives place to a wide zone of banded red and yellow jasper. Westward it plunges under a heavy overburden of sand and drift. Upon both sides is a conformable series of banded red and yellow jasper, that forms the walls of the deposit. The foot-wall jasper is succeeded by the volcanic rocks of the mountain to the north. The hanging-wall jasper is overlain by a black finely crystalline limestone, which continues under the drift-sand of the valley.

All the outcropping rock within the dimensions given is celestite, although the material varies in texture and purity in the different strata. Some is darkly discolored by oxide of manganese, other portions are free from impurities, and in these the ore is finely crystalline, of a sugary texture and yellowish-white. It has a high specific gravity, but is appreciably lighter than barite, for which it has been mistaken. Analysis shows 95% strontium sulphate.

A number of veinlets, two to three inches wide form fibrous crystalline celestite, with the typical pale-blue tinge from which the mineral derives its name. The longer axis of the crystals lies across the course of the veinlets, their length being determined by the width of the latter.

In many instances celestite deposits appear to be the result of precipitation and to have an origin analogous

to that of gypsum, which is associated with them. Gypsum does not occur in this deposit, but jasper, which is often recognized as precipitated silica, is an important associate. Precipitation can with reason be held to ac-



OUTCROP OF CELESTITE NEAR LAVIC, CALIFORNIA.

count for the celestite in this instance but other conditions observed preclude the application of this theory and suggest one wherein circulating hot waters, with strontium compounds and silica in solution, have attacked a sedimentary series along an igneous contact, resulting in extensive replacement of limestone by celestite, and of calcareous and silicious shales by jasper.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

FARTHEST NORTH for a cyanide plant is claimed by the Willow Creek mill on Cook's inlet, Alaska. The latitude is 61° 45' N.

GOLD-BEARING arsenical minerals (mispickel and lollingite) are floated with difficulty at the Tul Mi Chung mill in Korea.

WATER-TIGHT canvas can be made by coating it with a mixture of five parts of coal tar, one part gasoline, and one part japan dryer.

TEMPERATURE of flotation concentrate at the Inspiration Consolidated affects the rate of filtration on Oliver machines, and arrangements have been made to use hot water from condensers.

GRADING in soft material during wet weather, when the working place is likely to become a quagmire, always justifies the laying of tracks and the use of cars, even if both track and cars are of rude construction.

IN 1905 and 1906 the Elmore bulk-oil process was used at the Massey mine, in Ontario, with success, as regards recovery, which was 87%; but the cost of the oil, too much of which was wasted, rendered the operation uneconomical.

DAMPERS placed in ventilation pipes in mines should be made of extra heavy sheet iron or steel or they will be found to be severely bent by concussion due to blasting; the tendency to double up will always be inward, not outward, as may be supposed.

AT OURO PRETO, in Brazil, the *jurupeba*, one of the *solanaceae* and a soap-bearing plant, is used in the Passagem stamp-mill to hasten the settling of fine gold, that is, to prevent the floating of gold. This effect is due to lowering of the surface tension of the water.

THE TRACK-JACK is one of the most useful tools about a mine either on the surface or underground. It is useful not only in adjusting the grade of tracks, but in replacing derailed cars and in numerous other ways. It is easily carried, quick and direct in action, and once employed seems indispensable.

ALASKITE was a name originally applied by J. E. Spurr to aplite that contained a large amount of quartz, much of which was due to the secondary deposition of silica, great quantities of which he found in some parts of Alaska. The term has more recently been extended to include all rocks composed principally of quartz and alkali feldspar.

TITANIUM is a silver-white metal with a specific gravity of 4.5. It occurs most commonly as rutile, titanium di-oxide. Titanium unites with other metals to form alloys; an alloy of titanium and iron is used as a de-oxidizer in the purification of steel. Carbide of titanium is formed at high temperature. This is known commercially as ferro-carbon-titanium, and is made by reducing titaniferous iron ores in an electric furnace.

IMPURITIES most common in magnesite are alumina, silica, lime, and iron. Buyers generally penalize too much of either of the first three, but for some purposes make no objection to the iron unless it occurs in excess of 5%, preferring iron up to 3 or 4% in the raw ore. Silica is permissible up to 5% if the magnesite is to be used for furnace linings. In chromic iron the usual impurities are alumina and ferrous iron, neither of which substances can be detected readily by the eye, though an analysis promptly discloses their presence.

CONCRETE may be placed successfully in freezing weather by heating the rock and sand, and the water used in making the mixture, just before it is placed in the forms. In some instances concrete thus placed has been protected from freezing by arranging improvised radiators of 2-in. pipes at the sides of the concrete mass, turning steam into the pipes, and covering the whole with tarpaulins. In other cases, a constant flow of hot water has been discharged on the concrete, which permitted the cement to set firmly before freezing should cause it to disintegrate.

STEEL CABLES may be either cut or welded by means of the oxy-acetylene flame, but a broken cable welded by this method would have its usefulness as a hoisting rope largely impaired, if not destroyed, for the reason that the individual wires composing the cable would have their tensile strength diminished by the process of annealing, which could not be avoided. Cables welded by this method might safely be used for standing-ropes when the tension to which they will be subjected never exceeded 50% of the original guaranteed tensile strength, as stated by the manufacturers of the rope.

CAUSTIC SODA is added to ball-mill pulp—containing 35% moisture—at the Tul Mi Chung plant of the Seoul Mining Co. in Korea. The addition at this point is considered essential in the treatment of the gold-copper ore, as the colloid slime becomes flocculated as soon as liberated, and allows the eucalyptus oil freer access to the mineral particles. To such an extent is this the case, that when ore is being milled containing appreciably coarse mineral particles, they are immediately floated out of the mill and freed from the risk of over-grinding. Prior to the addition of caustic soda at the ball-mill feed, the colloid slime appeared to coat and protect the sulphide mineral particles from oiling. The quantity added, as a 20% solution of NaHO, is 2 lb. per ton; and of eucalyptus oil 0.6 pound.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

BUTTE, MONTANA

COMPENSATION RESULTS.—TUOLUMNE COMPANY'S PROPERTIES.—
DAVIS-DALY AT DEPTH AND ZINC.—NEW COMPANY.

There are 1675 employees operating under the Workmen's Compensation Act. Practically all of the mining companies in the State are included in this total. Three plans were provided for carrying the risk. Some of the companies carried their own risk, and paid compensation direct to their injured men. For the 17 months that the law has been in effect their accident costs averaged less than 0.5% of the annual pay-roll. Under No. 2 plan, insurance companies paid the employee's claim, and collected premiums from the employers. The 13 different insurance companies had an accident cost of about 0.5% of the annual pay-roll. Under the third plan the State took the place of the insurance companies, and the cost was found to be about 0.5%. The costs prove conclusively that the premiums charged by insurance companies are too high. The premiums charged by the State amounted to less than 1%, which is perhaps the cheapest insurance protection in existence. During the 17 months there were 10,241 accidents reported, of which 197 were fatal. The few complaints made show that the law is giving complete satisfaction.

Tuolumne company's development on the 700-ft. level of the Butte Main Range mine continues satisfactory, and no doubt the property will develop into a good mine. The ore was found in a cross-cut that was driven south from the Sinbad shaft. The Spread Delight vein was cut, showing 4 ft. of 4% copper ore. Farther south, vein-material and altered granite were found, and then a body of ore 30 ft. wide was penetrated. The first 10 ft. averaged over 5% copper, and the remainder is said to be payable ore. Tuolumne controls the vein for a distance of 2400 ft. along the strike. For 1100 ft. the vein is in the Main Range. It crosses into the Colusa-Leonard to the west, which is also under option to the Tuolumne. A drift is being driven along the strike of the vein with encouraging results, and arrangements are being made to cross cut to the vein from the Colusa-Leonard shaft. The development will lend new impetus to the exploration that is being prosecuted in the eastern part of the district, and it is probable that several large mines will be developed in ground that has been repeatedly scorned by geologists. Of course, the present high price of copper could not be foreseen by geologists, and it is true that all these properties would be scrambling to make both ends meet if copper were selling for 16c, but it now seems certain that orebodies will be developed that can be worked with great profit after copper returns to its normal price.

It is rumored that the North Butte will sink a shaft in its ground east of the Main Range to explore veins at depth that have recently been exposed in an adit driven on the North western claim. The Tropic, Bullwhacker, and Butte Duluth, all in the eastern section, continue to yield good ore.

The Davis Daly is attracting much attention, and its shares have risen to several times their former price. Development on the 2500-ft. level is said to have disclosed a large body of high-grade copper ore. On the upper level, most ore was encountered, but because of extensive faulting none of the ore shoots were long enough to make the mine profitable. The company had to spend more for development to keep the mine in ore than the profit on the ore amounted to. The ore, found at 2500 ft. is said to be much better and wider than anything

found heretofore. New hoisting equipment is being installed, and a greatly increased production may be expected when it is ready. For some months past production has averaged 100 tons per day; the profit from this, even at the prevailing high price of copper, was not enough to meet expenses. With an increased production the cost will be materially lower, and a good profit should be made. Davis-Daly's position as a prospective producer of zinc has been greatly over-estimated. No ore has been developed in the Hibernia claim, and no commercial zinc ore has been developed in ground near it. The Hibernia has a good surface showing, but at best it is only a good prospect. In the Hesperus claim some narrow veins of high-grade zinc ore have been explored, and the ore will return a good profit if it is mined while the price of spelter is high. The tonnage developed, however, has been greatly exaggerated in the local papers, and has been favorably compared with the orebodies in the Rainbow lode that runs through the properties of W. A. Clark and the Butte & Superior. The veins in the Rainbow lode are from four to eight times as wide as the zinc-bearing veins in the Hesperus, and the shoots in the Rainbow are many times as long as any that have been discovered in the Hesperus.

A company has been incorporated to explore the Britannia and adjoining claims in the south-western part of the district. The Britannia is one of the old silver producers, and was worked for this metal to a depth of 700 ft. The veins that can be cross-cut from the old shaft are wide and long. The indications that point to commercial ore of the base metals at greater depth are as strongly developed here as at any point in the entire district. The management is capable and efficient. Of all the properties in Butte that are in the development stage this is the best gamble.

OUTMAN, ARIZONA

CONDITION OF THE UNITED EASTERN AND TOM REED MINES.

On about December 25, the exact time depending on the arrival of a consignment of cyanide, the new 200-ton mill of the United Eastern Mining Co. will commence, and shortly after should produce \$4000 to \$5000 of bullion per day. This plant will no sooner start than the Tom Reed Gold Mines Co. will commence the construction of a second unit of its mill, to increase the capacity from 150 to 300 tons per day. While this work is under way the Big Jim Mining Co. will have concluded its plans and will have let contracts for the machinery for a 400-ton cyanide mill which should be in operation within a year.

The United Eastern mill is a modern all-sliming plant employing the continuous counter-current system of decantation and agitation. The ore is crushed in solution in two 200-ton Marx ball-mills and ground to 200-mesh in three Allis-Chalmers 5 by 6-ft. pebble-mills with a capacity of 133 tons each with 85% through 200-mesh. The machinery is electrically driven. The gold of Outman mines is free and the ore requires fine grinding. The report of the Tom Reed company for the last fiscal year shows an extraction of 98.6%, crushing to 200-mesh. The crushing and grinding department of the United Eastern mill is designed to reduce 400 tons per day, but the capacity of the vats is limited to 200 tons. The mill is so constructed that the capacity can be increased at slight cost. Precipitation is by Merrill zinc-dust

system. The accompanying picture shows a compact arrangement of shaft equipment and mill.

The company recently sank a 3-compartment shaft to a depth of 725 ft., which has been connected with the vein, first opened through No. 1 shaft, on three levels. The shaft is timbered with 10 by 10-in. lumber, and arranged with ore-loading pockets on each level. The bins on each level have two compartments, one for each compartment of the shaft, and the pockets are so constructed that they contain an exact load for the skip. The cross-cuts are electric-lighted, and the shaft equipped with electric-flash signal system.

The development of the United Eastern mine from a rather doubtful prospect to a great gold mine, accomplished in two years' work, of which the greater part has been done within a year, is a splendid result. The company's property adjoins part of the three or four miles of land owned by the Tom Reed company. It was located by one Joe Perrizi, and as a result of his faith and perseverance he is now possessed of a fortune of \$250,000. In the autumn of 1913, J. L. McIver, who

opened on the 565 and 667-ft. levels, had exposed "sufficiently for sampling and assaying, 200,000 tons of ore assaying higher than \$20 per ton and having a gross value of \$5,000,000." Subsequent work has doubtless increased this quantity. Thus a mine was made, and incidentally several huge fortunes. At present market prices for the shares, Long and Melver are worth not less than \$750,000 each. W. K. Ridenour, who had faith in the mine when it was a prospect, bought treasury shares from Long and Melver at 25c. each. These are now worth about \$5 each. Wiseman, Mudd, Keith, and D. C. Jackling, who joined the first named trio, have profited also. Joe Perrizi sold 10,000 shares, according to rumor, bought an automobile and toured the country, and is now living luxuriously at San Diego.

No. 2 shaft was sunk about 300 ft. from the vein, which it should cut at 950 ft. This shaft is being sunk, and will be continued until the vein is intersected.

The Tom Reed company has opened a large vein in the south-east end of its ground and is rapidly developing this.



No. 2 SHAFT AND NEW MILL OF UNITED EASTERN AT OATMAN.

is known throughout Western camps as a champion double-hand driller, secured a bond on the Perrizi holdings, and with his partner, G. W. Long, organized the United Eastern Mining Co. Long and Melver had hard sledding, and for many months made slow progress in development, selling a few shares and working for wages in the Tom Reed mine to keep going. In December 1914, Frank A. Keith, Seeley W. Mudd, and Philip Wiseman, of Los Angeles, after an examination of the property by C. H. Palmer, Jr., contracted to purchase a large number of treasury shares for further development of the mine. A small gasoline hoist was installed and prospecting resumed under George W. Long. The shaft passed through the vein at 200 ft., where it was small, the best assays being \$8.78 per ton. At 300 ft. a cross-cut was driven to the vein which showed a width of 12 in., assaying \$14 to \$27; this was in October 1914. The important strike was in March 1915. At a depth of 465 ft. a cross-cut from the shaft exposed 25 ft. of ore that assayed \$22.93 per ton. Subsequently a drift driven along the foot-wall opened a shoot for 650 ft. in which some rich ore was found. At places on this and other levels the shoot is 40 ft. wide, an unbroken body of gold-bearing quartz excepting for an occasional horse of andesite. In May 1916, J. A. Burgess was appointed general superintendent. In June following he made a report stating that the mine, which had then been

The existence of a vein in this part, which is a mile from the main workings, has long been known, but it was not until the discovery on the Big Jim mine, which adjoins the Tom Reed on the east and south, that active development was undertaken. A shoot of good milling ore has since been proved for a length of 1100 ft. At a depth of 200 ft. on the Bald Eagle claim 33 ft. of quartz was exposed in a cross-cut, of which 26 ft. assayed \$9 to \$10 per ton. Farther south, 650 ft., the Aztec workings at 400 ft. cut 18 ft. of ore, of which 12 ft. on the hanging wall assayed \$8.50 and 6 feet on the foot-wall \$14.50. A drift was extended north-east 350 ft., and in several places face samples across the 6 ft. of drift assayed up to \$50 per ton. The entire 350 ft. is officially reported as milling ore of excellent grade. The shaft at 450 ft. is in 8 ft. of quartz worth \$13.88. Mine and mill costs are under \$6 per ton, so this grade of ore pays well. It is expected that the new unit of the mill, which will be equipped with Marcy ball-mills, etc., will lower the costs to \$5 or less.

Bulletin No. 43 of the University of Arizona at Tucson, by P. E. Joseph, deals with iron. Ten pages give the composition, characteristics, and tests for iron minerals, and three pages discuss the origin and uses. Some iron ores, such as the oxides and pyrites, occur in Arizona, and are used as fluxes, but no metal has ever been reported as made from the ores.

TORONTO, ONTARIO

FOREST FIRES AND PREVENTION.—RESEARCH COUNCIL.—PORCUPINE AND COBALT DEVELOPMENTS.

Important legislation embodying more effective means for the prevention of forest fires, which, with the opening of the wooded areas of Northern Ontario, are a continually increasing source of danger to the mining centres, is promised by the Provincial government. Last week a large and representative deputation waited on the Hon. G. Howard Ferguson, Minister of Lands, Forests, and Mines, to urge the need of stronger preventive measures and were assured that the Government was alive to the need for a thorough re-organization of the fire-prevention system to meet the new conditions. The first step taken was by establishing a separate branch of the Department with full control of the forestry and fire-prevention service, of which E. J. Zavitz has been appointed chief, with extensive power. The contemplated reforms, for which the sanction of the Legislature will be required, include the adoption of the permit system for the clearing of settlers' lands under which no burning of brush will be allowed, except under official direction, and the establishment of observation towers, trails, and a telephone system in connection with the fire-ranging service. It is also proposed to give the municipal councils more extended authority for fire prevention, and jurisdiction for some distance outside of town-limits.

The Canadian Government has appointed a number of scientists, engineers, and steel experts as an Honorary Advisory Council on Industrial and Scientific Research for the purpose of promoting the application of scientific methods to production and manufacture, utilizing waste products and discovering new processes. The Council consists of A. Stanley Mackenzie, president of Dalhousie college, Halifax, chairman; Frank D. Adams, and R. F. Ruttan, of McGill University, Montreal; J. C. McLennan and A. B. Macallum, University of Toronto; Walter C. Murray, president of Saskatchewan University; Robert Hobson, president of the Steel Company of Canada, Hamilton, Ontario; R. A. Ross, consulting electrical engineer, Montreal, and Tancrede Bienvenue, general manager of the Banque Provinciale, Montreal. The Council with others will carry on scientific and research work, and co-ordinate the work as far as possible to avoid overlapping, selecting the most practical and pressing problems and assigning them to research institutions for an early solution.

Porcupine had a three days' inspection last week from a large party embracing the members of the Standard Stock Exchange, Toronto, and a number of American capitalists from New York, Boston, and other points, as guests of the brokerage house of Mark Harris & Co. They visited the large mines, the principal object of the trip being the inspection of the Newray. It is anticipated that the result will be a considerable influx of American capital.

During November the production of bullion at the Dome mines was \$177,000, from the treatment of 37,900 tons of ore, valued at \$1.67 per ton. Operating costs of \$2.88 per ton were the highest for the year.

The 4-weekly statement of the Hollinger Consolidated for the period ended November 3 shows gross profits of \$241,591 from the treatment of 49,956 tons of ore, averaging \$8.62 per ton. The working cost was \$3.64 per ton. The deficit on the increased scale of dividends caused by the merger was \$238,118. The directors have ordered an issue of 120,000 shares of treasury stock, which will be offered to shareholders at \$6.50 per share, in the proportion of 1 share for every 40 old shares. The money to be raised will pay off the liability due to the shareholders of the Aene, Millerton and Canadian Mining & Finance Co. under the terms of the merger amounting to \$720,000, and leave a substantial sum towards the wiping out of the present deficit.

At the Lally, free gold is showing in the quartz vein, and the company is asking tenders for 1000 ft. of diamond-drilling

At the Davidson, Frank G. Stevens, the new managing engineer, has assumed control, and active development is meeting with good results. A raise from the 100-ft. level has exposed ore 8 ft. wide. Two small veins with free gold have been picked up 50 ft. in No. 2 shaft. D. R. Thomas has been appointed mine manager.

During November, the Schumacher produced \$18,295, at a cost of \$15,000. The new shaft has reached the 200-ft. level, where a station is being cut.

Sinking has been started at the Gold Reefs. The shaft now down 30 ft. will be sunk to the 100-ft. point at which cross-cuts will be driven to cut rich veins showing on the surface.

At the West Dome new equipment has been installed after considerable delay. The new 12-drill compressor is being operated by a 100-hp. motor. Forty-five men are employed.

An important strike has been made on the Aurum, formerly known as the Smith-Curry, in Munro Township, where a 4-ft. vein, showing free gold, has been opened.

Recent operations on the Ophir at Cobalt show encouraging results. In the cross-cut now at the 425-ft. level seven small veins were found within a distance of 20 ft. Three of them have united forming a strong vein 14 in. wide, and it is thought that they all converge into a considerable orebody. The important feature of this is that it shows an extension for about a half mile to the south of the silver-bearing belt on which the Beaver and Timiskaming are working.

The National Mines, operating the old King Edward under lease, is pursuing a deep-mining policy, and has sunk to the contact at 1170 ft., where a station has been cut and cross-cutting commenced.

WASHINGTON, D. C.

MINING LAW REVISION DOUBTFUL THIS SESSION.

No mining legislation is to be attempted in the present short session of Congress, at least this is the announcement of the House Committee on Mines and Mining, of which Representative Foster of Illinois is chairman. It is this committee that has set about the revision of the mining laws on its own responsibility, with the help of the mining authorities in Washington. Out of this has come the so-called Foster bill, which has been caustically criticized by the mining profession. This criticism has not been without force. It has served for one thing to make the Foster bill impossible, so that it is declared as dead, although really it may be said that it was written simply as a suggestion for the contemplated revision and codification of laws. Since then a concession has been made by the Committee, and that is to receive a bill which those mining men opposed to the Foster bill conceive ought to constitute the revision and which they are to draw up. Of course the House Committee refuses to commit itself with respect to this, but it will not be very welcome. All that members of the Committee will say is that it ought to serve as a good topic for discussion. It is expected that this bill will arrive during the present short session; but nothing is to be done regarding it in the way of substantial advance, for it is recognized that the session is too short for action in this Congress, even if an agreement respecting mining legislation could be reached. The Committee is as irreconcilably opposed to a separate and independent codification commission as ever. The chances for legislation in the next House can hardly be forecasted. For one thing, it is still in doubt which political party will control the next House, if any; there may have to be a coalition. So the complexion of the next committee on mines and mining of the House remains in doubt. One member will not be on it, and he is Delegate Wickersham of Alaska. He was defeated in re-election. Although without a vote in the Committee he had great influence over it, and has been the chief obstructionist to the revision and codification as desired by many in the mining profession, and recognized as being necessary.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

CHLORIDE. Roads in the vicinity of Chloride are in poor condition for teams, and all concerned are being asked to help in their improvement at an early date.

The district maintains its activity, especially in the copper zone. In the 170-ft. level of the Copper Age the shoot is 300 ft. long and 3 ft. wide, worth \$40 per ton in gold, silver, copper, and other metals. Foundations are being prepared for the concentrating mill.—The Diana claims have been bonded to G. Beveridge for \$20,000.—The Arizona-Chloride company has been completely financed.

JEROME. This centre has two large copper producers, the United Verde and the United Verde Extension. Eleven others have ore, namely, the Copper Chief, Pittsburg-Jerome, Arkansas & Arizona, Dundee, Verde Apex, United Verde Consolidated, Shea, Grand Island, and others.

MIAMI. At the Inspiration Consolidated it is proposed to enlarge the miners' change-house, the present one being overcrowded. Erection of a duplicate motor-generator set is under way at the mine power-house, to serve the hoists. Structural work on No. 19 and 20 units of the mill is finished. Foundations are to be prepared for the new flotation-plant blowing-engines. Ingersoll-Rand centrifugal and Root rotary blowers are used. Experiments are being made in leaching tailing.

The Miami Copper Co. filed a statement with the Court regarding its November results, as follows: pulp treated by flotation, 120,988 tons; copper in feed, 1.157%; concentrate produced, 1589 tons; copper in concentrate, 41.439%; copper in residue, 0.621%. The profit from this treatment was \$299,396. The feed had already been treated by water concentration.

OATMAN. A good development is reported from the Gold Road mine, details of which should be available soon.

CALIFORNIA

'Borax in 1915,' by Charles G. Yale, has just been issued by the U. S. Geological Survey. The output of crude borate materials in the United States was 67,003 tons, valued at \$1,677,099. In 1914 the yield was 62,400 tons and \$1,464,400. All the crude mineral is colemanite (calcium borate). The deposits are shown on the accompanying map. The production is derived entirely from California ore. The famous Lila C. mine of the Pacific Borax Co., in the mountains of the Death Valley region of Inyo county, after making a final small output early in 1915, was abandoned, and the company confined its efforts to the Biddy McCarthy and Widow mines, two new properties opened and made productive in 1915. A small 18-in. tramway connects with the narrow-gauge line to the main line of railroad. At this property more rotary furnaces are to be put in. At the Lang property of the Sterling Borax Co., in Los Angeles county, the calcining plant has been enlarged and new deposits have been opened. New rotary Wedge furnaces have also been put in. The Stauffer Chemical Co., of San Francisco, did not make any production at the Russell borate mines in Ventura county in 1915.

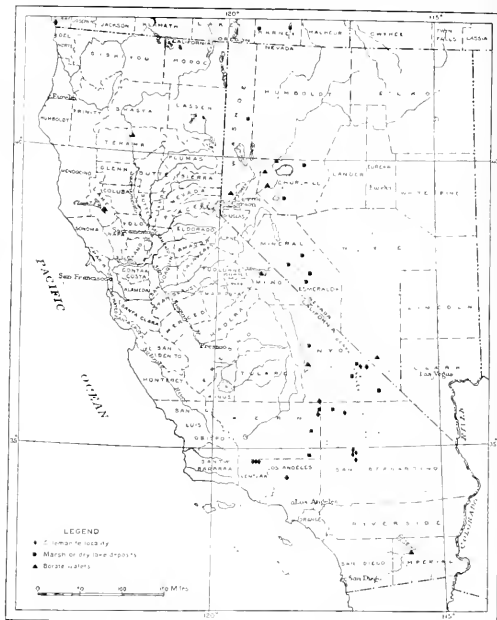
JACKSON. To cyanide tailing from the old Argonaut mill, Simmonds & Latham of Melones, Calaveras county, are to erect a plant costing \$15,000. There are 200,000 tons stored, which average from \$1.75 to \$2.50 per ton.

LEWISTON. The dredge on the Trinity river has been digging rich gravel, yielding much fine gold and nuggets. After

a 16-day run there was \$19,748 recovered. Chico people operate the Lewiston Dredging Company.

PLYMOUTH. According to W. J. Loring, the Plymouth Consolidated has produced nearly \$1,500,000 from 270,000 tons of ore in 27 months, of which \$460,000 was clear profit. The shaft is 2450 ft. deep, and is to be sunk 300 ft. lower. Reserves amount to 180,000 tons.

(Special Correspondence.)—Copper mining in Plumas county is exceptionally active. At Gullwing, the Walker mine, controlled by the International Smelting Co., is employing 75 men and is shipping concentrate. A 100-ton flotation plant is in operation and its capacity may be increased next summer. Small amounts of gold and silver occur in the ore.—A



MAP SHOWING BORAX DEPOSITS IN THE WESTERN UNITED STATES.

short distance from the Walker is the Bonita group, recently acquired by the Walker Bros. Consolidated Co. of Salt Lake City. Work has been going on for four years with encouraging ore exposures. A compressor and three machine-drills have been installed, and electric power will be extended to the mine as soon as the weather permits. Work started with H. L. Allread as superintendent. The Boca & Loyaltan railway, controlled by the Western Pacific, has arranged to extend its Grizzly Creek spur five miles, which will greatly facilitate ore shipments from this district.

Following a short-lived strike, influenced by I. W. W. agitators, the Engels Copper Co. has resumed operations near Taylorsville. The men demanded their wages be increased from \$4 to \$5 per shift, and for a time serious trouble was feared, as the strikers were promptly discharged and opera-

tions discontinued. Approximately 300 men are now at work, and a normal tonnage is being treated by the flotation plant. Driving of a main lower adit is progressing, and more equipment will be added to the plant shortly.

Many of the old gold producers of the county are active. At the Jamison mine, near Mohawk, 60 men are employed and the mill is running on good-grade ore.—Operations have been resumed at the Plumas Eureka, and an extensive campaign of development has been outlined. The property is a short distance from the Jamison.—A number of gold properties at Gold Lake, Beckwith, and other old centres are receiving attention.—Representatives of an Eastern syndicate have taken options on several copper properties at Greenville, and are preparing for thorough prospecting.

Quincy, December 19.

COLORADO

On January 9, 10, and 11 the Colorado Metal Mining Association meets at Denver. Among questions to be considered for a definite plan of action are the following: (1) Proposed repeal of the present law for the taxation of producing mines; (2) proposed change in laws regarding the Industrial Board and compensation insurance; (3) action of Association regarding regulation of smelters by Utility Commission; (4) proposed tariff laws affecting tungsten and other metals mined in this State; (5) co-operation of the State Association with similar organizations of other States for mutual benefit; (6) proposed changes in Federal mining laws; and (7) Government conservation policies and continued withdrawal from development of public lands.

At a meeting of a special committee of the tungsten producers of this State, appointed by the president, Bulkeley Wells, and composed of the following members: Harold Boericke, Primos N. & M. Co., Boulder; J. A. McKenna, Vasco M. Co., Boulder; Robert M. Keeney, Rare Metals Ore Co., Denver; J. G. Clark, Boulder Tungsten Production Co., Boulder; William Loach, Wolf Tongue M. Co., Boulder; Forbes Rickard, Ragged Top M. Co., Denver; Platt Rogers, Rogers Patent, Denver; Horace Holmes, Luckie 2 M. Co., Boulder; Geo. W. Teal, Tungsten Metals Co., Boulder; William Cowdry, Long Chance M. Co., Nederland; Nelson Franklin, Rare Metals Ore Co., Rollinsville; and H. N. Brown, Mojave Boulder Tungsten M. Co., Sugar Loaf; it was decided to call a meeting of the tungsten producers of the United States to convene during the annual meeting of the Association. This meeting is called for the purpose of a conference of the tungsten producers of the country to formulate a plan for concerted action in all matters affecting the industry, and especially to unite in an effort to secure as early as possible, favorable action on the part of the proposed tariff commission in behalf of a duty on tungsten ores and the products thereof.

LEADVILLE. The Derry Ranch dredge has been stopped for the winter, after working continuously for 8 months. Over 500,000 cu. yd. of gravel was dug, averaging at least 50c. per yard. In February the boat will be overhauled. R. E. Lafferty is manager.

At the Emmet shaft the Empire Zinc Co. is installing a G. E. 52-hp. hoist to replace an old steam engine, also a motor-driven compressor. Water in the Greenback shaft has been lowered to 1350 feet.

The Monarch company is to sink its shaft 100 or 150 ft. below the 750-ft. level.

At the Jamie Lee shaft of the I. S. S. R. & E. Co., a 105-hp. electric hoist has been put in place. Rubbish and mud in the shaft has hindered cutting out a pump station.

SHARON. According to the *Week's Mining* and *Trade* shipped approximately 60,000 tons of ore worth \$3,000,000 during 1916. In 1915 the quantity was only 500,000 tons. Snow prevented any shipments in January. Lead ore was mined near the Sunnyside, S. D. & G., Gold King, Doves, and other towns.

Tiger, St. Paul, Dives Leasing, Silver Ledge, and Silver Lake. Local custom mills were busy during the summer, and improved methods gave better recoveries. The coming year is expected to be a better one.

SNEFFELS. The report of the Atlas Mining & Milling Co. for the year ended June 30, 1916, contains the following information:

Underground development advanced 1681 ft. on the Klondyke vein, with favorable results. The amount of broken ore in reserve was increased by 9000 to 12,000 tons, worth \$75,000. An electric storage-battery loco replaced horses and mules in March, giving all-round better results. The mill treated 36,647 tons of ore averaging 0.0422 oz. gold, 9.19 oz. silver, and 35.2 lb. lead, worth \$6.77 per ton. Oil flotation gives 25% better recovery than by the tables; on gold this was 83.9%, on silver 87.9%, and on lead 90.4%. In June the average was 92.3%, and in November 93.6% silver and over 90% lead. Costs were as follows: Mining, \$1,8603; milling, 94.37c.; tramway, 10.27c.; maintenance, 23.49c.; development, 47.56c.; transport and marketing, \$1,2334; management, 19.37c.; taxes, 3.5c.; bond interest, 11c.; royalty, 12c.; and insurance 7.21c.; a total of \$5.3814 per ton. The year's revenue totaled \$212,156, of which \$17,265 was operating profit, less \$8437 for improvements.

IDAHO

ADAMS. Control of the Richmond Mining & Milling Co., which owns and is operating a group of six copper claims near here, has been secured by New York capitalists for a reported price of \$350,000, or on a basis of approximately \$500,000 for the entire property. The mine was reported on by B. N. Sharp, whose estimate of reserves was \$375,000 net. The average copper-content is 11%.

KELLOGG. According to S. A. McCoy, president of the Kellogg United Mines Co., a 100-ton mill and other equipment costing \$50,000 will be erected in the spring. The mine contains 40,000 tons of lead-zinc-silver ore, with recent developments indicating much more.

MURRAY. It is rumored here that the Guggenheim Exploration Co. has acquired a large tract of dredging ground along Prichard creek, and that prospecting will be continued next season.

PINE CREEK DISTRICT. The Douglas mine of the Anaconda company is shipping 20 tons daily of selected zinc-lead ore to Montana for electrolytic treatment, while preparations are under way to install new machinery.—The Highland-Surprise is the largest shipper in the district.

MICHIGAN

Houghton. Copper production of the Lake Superior region in 1916 will total 260,000,000 lb., a record. No Sunday work is done, this making the output 40,000,000 lb. less than it would have been, worth at 25c. per pound, \$10,000,000.

To July 1, 1917, the Calumet & Hecla and subsidiaries will pay 10% additional wages, while the present bonus of 25c. per day will be increased to 50c. The Mohawk and Wolverine companies will also pay the 50c. bonus.

The Quincy mine is producing 4200 tons of ore daily; one day's output was 1600 tons. This comes from three shafts.—Franklin is producing 1000 tons, to be 1300 tons by March.

After much delay, due to slow delivery of steel, the Champion has completed the frame of its re-grinding mill.

The threatened coal shortage in the Lake Superior region this winter will affect the smaller companies much worse than the others. The district, according to some of the largest dealers, is about 300,000 tons of coal short of actual needs. About the same quantity was shipped in as a year ago, but the mining companies were unable to get in the amount they ordered. The Calumet & Hecla company, alone, will be about 100,000 tons short. This company and its subsidiaries use 1,000,000 tons per annum. Plans for conservation of fuel

have been worked on by the company's officers for some months.

The Calumet & Hecla reports as follows for November, in pounds:

Mines	Month	11 months
Abmeek	2,157,959	21,820,622
Allonez	815,458	9,449,067
Calumet & Hecla	6,513,333	70,338,187
Centennial	155,505	2,174,350
Isle Royale	1,036,492	11,298,297
La Salle	135,220	1,211,141
Osceola	1,533,944	18,024,665
Superior	204,487	2,780,179
Tamarack	504,831	6,036,240
White Pine	314,534	3,969,142

MISSOURI

JOPLIN. Severe weather curtailed ore production last week. The coal situation—shortage and high price—is serious. Zinc ore declined \$5 per ton, while lead ore rose \$3. The output of the Missouri-Kansas-Oklahoma region was 9634 tons of blende, 342 tons of calamine, and 1241 tons of lead, averaging \$86, \$48, and \$90 per ton, respectively. The total value was \$965,004.

MONTANA

BUTTE. On the 1000-ft. level of the Butte & Zenith City mine the north cross-cut cut the hanging wall of the Paint vein. The casing has considerably altered granite mixed with it, and assays 1.45% copper and 3 oz. silver per ton. The south cross-cut and east drift is after the Economic vein.

The north cross-cut on the 1600-ft. level of the Butte & London has passed through 25 ft. of formation, 18 ft. assaying 1.2 to 8% zinc and several ounces of silver.

A gas pocket has been encountered during unwatering and repairing the Butte & Bacorn shaft, causing a slight explosion last week.

NEVADA

ELY. Effective from December 1 the Nevada Consolidated company is to increase wages 25c. per shift, to be paid while copper sales average between 27½ and 30c. per lb.; when the average is 30 to 32½c., another 25c. per shift will be paid to those employees receiving \$3 per day; while those getting under will receive a bonus of 20 cents.

LOVELOCK. In the Seven Troughs Coalition mine a winze is being sunk to 1900-ft. depth. This is to cut through the broken zone recently encountered. The mill continues to make a profit.

ROCHESTER. During 1916 the Rochester Mines Co. yielded approximately \$400,000, against \$334,157 in 1915, \$279,659 in 1914, and \$399,025 in 1913, a total of \$1,412,841.

TONOPAH. Last week the district produced 10,996 tons of ore valued at \$198,666. Some November outputs are as under:

	Tons	Oz. bullion	Profit
Belmont	12,027	230,058	\$121,265
Extension	9,019	145,973	52,670
Jim Butler	4,020	.....	31,572
Tonopah Mining	8,555	167,315	50,550

VIRGINIA CITY. On December 21, water in the North End mines of the Comstock was down 38 ft. below the 2700-ft. level, which is good progress. The unwatering to 2900 ft. is being done through the Mexican-Ophir joint winze.

The Comstock Phoenix property, in a fissure running diagonal to the Comstock lode, has been acquired by Jesse Knight and others of Salt Lake City. The 650-ft. shaft is to be sunk to several times that depth.

NEW MEXICO

CUBA. In this district of north-central New Mexico, copper properties belonging to J. T. McLaughlin and others have re-

cently been sold, and ground will soon be broken there for a plant using modified pyrite smelting devised by Mr. Greenwald. This plant will utilize the sulphur deposits in the vicinity of Jemez springs, 30 miles away. The haul will probably be made by wagon, only a few tons of the low-grade sulphur-bearing travertine being required to add to the partly chalcocitic Cuba ores. These ores are of the bedded sandstone type, such as are found at Scholle, New Mexico.

(Special Correspondence.)—Three feet of \$12 ore has been opened in the south drift from shaft of the Eberle mine. The Oaks company will mill this as it does other ores at the Socorro mill.

At the Pacific mine, construction work is about completed for hoisting from the adit-level to the collar of the shaft. The ore will be dumped into chute to crusher, thence by belt-conveyor to bins at terminal of the aerial tramway to the Socorro mill. At present a large number of burros are employed moving an old ore-dump to the terminal station.

A new head-frame has been installed at the Trilby group, and sinking and driving will be started at once.

The Oaks Company has resumed sinking of the shaft on the Meridian claim. This is a fraction lying between the Top, on the east, one of the properties under operation by the Mogollon Mines Co., and the Confidence group on the west.



WINTER ALONG THE COMSTOCK, NEVADA.

which together have produced over \$5,000,000. Although surface rights are restricted, the fraction is considered valuable, as it embraces a constantly increasing length of this important vein as depth is gained.

Mogollon, December 12.

SILVER CITY. G. H. Utter has sold for \$200,000, on terms, to Los Angeles and New York capital the Jim Crow-Imperial claims in the Steeplecock district. The property contains gold and silver deposit. G. A. Whiteford of Los Angeles examined the mine.

OKLAHOMA

MIAMI. Drill-rigs are badly wanted in this district, which includes Cardin, Century, Picher, and Quapaw. One company, Church & Wright, wants 40 drills. For 3000-ft. contracts they will pay \$1.10 per foot. There are 200 drills working in the new district, and 500 around Miami. Drill-men are paid \$4.50 to \$5 per day.

OREGON

JACKSONVILLE. Little is published concerning mining in Jackson county. The reason why so little is being done is the short-sighted non-progressive crowd that 'guarded' the district and warned off would-be purchasers of properties, afraid that the mine-owners would not receive their dues. The county has had rich placer mines, and there are some that will still pay to work. There is also some likely looking ground in the ranges. A subscriber sends this news.

UTAH

ALTA. The daily output of the Alta district is irregular, due to the weather, but is from 150 to 250 tons.

The Emma Copper Co. expects to ship 30 tons of ore daily until the mine is further developed. A recent assay of 6 ft. of ore gives 175.6 oz. silver, 21.1% lead, and 0.91 oz. gold.

The Michigan-Utah is shipping 60 tons daily. A recent special carload was settled for, assaying 0.0325 oz. gold, 142.7 oz. silver, 11.9% lead, and 19.31% copper.

With 15 teams the South Hecla is able to move 50 to 75 tons of ore daily, and more regular shipments are expected.

GARFIELD. When the A. S. & R. smelter's additions are completed by about next November its capacity will be 6000 tons of ore per day, against over 2500 tons at present. There will be new furnaces, sulphuric acid plant, and electric apparatus; also a central bath-house for the 1500 employees. C. W. Whitely is manager.

MEXICO

Following is a translation of a decree by Carranza affecting the exportation of ores and metals from Mexico.

Considering that to aid in the re-construction of the country and to assist business back to normal, it is convenient to give necessary aid to home industries for the renewal of business that has been suspended and for the proper enlargement of those industries that have continued in operation; especially to the mining industry of such vital importance to the nation. It is well to give special facilities for the object indicated.

Therefore I have considered it advisable to make the following decree:

Art. 1. From December 10, 1916, to December 31, 1917, the export duties established by article 10 of the law of May 1, 1916, will be suspended.

Art. 2. During the time of suspension (December 10, '16, to December 31, '17) metals (for export) will pay the following rates: Gold and silver in bars, 5% of the assay-value; ores of gold and silver, 7% of the assay-value; copper in bars, 5% of value of metal; ores of copper, 6% of assay-value; other ores, 3% of value of metal.

Art. 3. To determine the value of the metals the Department of Hacienda will announce each month the prices that will apply for the following month, taking for a base, the prices given for metals in a separate circular by the Department of State.

Art. 4. If the value of copper goes below 20c. per pound in New York, the 5% for bars and the 6% for ores (and products) will be calculated on 95% of the New York quotation.

Art. 5. Exemption from export duties, established by Article 2 of addition G of the decree of May 1, 1916, will apply only in the following cases: Ores of copper less than 5% copper, ores of lead with less than 15% lead, ores of zinc containing less than 20% zinc.

Therefore, I send this to be printed, circulated, and complied with.

CONSTITUCION Y REFORMAS—Querétaro, Diciembre 8 de 1916.
V. CARRANZA.

Gold and silver bullion, and copper ore and concentrate, exported from Mexico to the United States, across the border, during 1916 totaled P24,827,169.

On December 19 the UTAH SECTION of the A. I. M. E. held its annual meeting and election at Salt Lake City. The following officers were elected for the ensuing year: C. W. Whitely, chairman; W. Wraith, vice-chairman; and Ernest Gayford, secretary-treasurer. Papers by J. M. Callow, entitled "Notes on Flotation, 1916," and by Irwin White, entitled "The Manufacture and Use of Sulphuric Acid," were presented. An address was also made by Major Westley King on "Military Conditions on the Mexican Border." The number in attendance, including the majority of the members of the local section and guests, was about one hundred.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

WILLIAM A. FARISH is at Salt Lake City.

HULKLEY WELLS is at the St. Francis hotel.

R. B. LAMB, of New York, is visiting California.

O. C. RALSTON spent Christmas at Colorado Springs.

LEON J. PEPPERBERG has returned from Salt Lake City.

T. WALTER BEAM is out of hospital, we are glad to state.

HORACE V. WINCHELL was recently in the Oatman district.

JOHN F. NEWSOM was at Salt Lake City just before Christmas.

IRA B. JORALEMON, of Bisbee, is spending the holidays at Berkeley.

FORBES RICKARD spent Christmas with his brother in Berkeley.

ETHELREIDE WALKER, of Boise, Idaho, spent Christmas in San Francisco.

J. E. JOHNSON, of New York, passed through San Francisco on his way to New York.

A. R. WEIGALL was at Kobe, Japan, during November, and has now returned to Korea.

SAMUEL WEIS, dredging engineer to the Lena Gold Mining Co., is purchasing machinery in San Francisco.

W. J. BLOCH has accepted the position of assistant superintendent of the Mile Wide Copper Co., near Tucson, Arizona.

EDWARD P. SCALON has been appointed superintendent of the Lincoln mine of the Inter-State Iron Co., at Virginia, Minnesota.

CHARLES B. CRONER is in charge of operations at the Bunker Hill mine, Inyo county, recently bonded to Los Angeles capitalists.

W. J. COX, manager of the Camp Bird, and HUGH ROSE, manager of the Santa Gertrudis, have been in London for the purpose of meeting their directors.

CHARLES T. KIRK, State geologist of New Mexico, has returned to Albuquerque from Oatman and the Big Bend country of northern Mohave county, Arizona.

FRANK LELAND has resigned as general manager of the Bala-kala and Trinity copper companies at Coram, Shasta county, to make his home in southern California.

JOHN ROBERTS MITCHELL, born at Perran Porth, Cornwall, in 1856, died at his home in Denver of heart disease on December 16. He spent some years in Ireland, where his father was manager for the Mining Company of Ireland; his first mining was in the Glendalough lead mines, county Wicklow; from there he went to Kimberley, accompanied by his brother James, and engaged in diamond-mining and in placer-work on the Vaal river. His next move was to America, visiting Leadville and the mining regions of New Mexico, settling down at Black Hawk, Colorado, in the early 'eighties; there he acquired a keen insight into the handling of low-grade gold mines. His next field of operation was the San Juan. Mr. Mitchell's superintendence of mines embraced California, Nevada, British Columbia, Mexico, and Alaska. For seven years he was superintendent of the Alaska Perseverance, now the Alaska Gold, and his work at that great mine received high commendation from the directors and stands as his best achievement. He was an able miner, a keen and progressive superintendent, a man of high character, and bore an unsullied reputation through the vicissitudes of 40 years in many lands. He is survived by a wife and son, a brother in Rhodesia, and by two sisters.

The annual meeting of the Colorado Metal Mining Association is to be held at Denver on January 9, 10, and 11. M. B. Tomblin is secretary.

THE METAL MARKET

METAL PRICES

San Francisco, December 26.

Antimony, cents per pound.....	12
Electrolytic copper, cents per pound.....	35
Pig lead, cents per pound.....	8.00—9.00
Platinum, soft and hard metal, per ounce.....	\$85—91
Quicksilver, per flask of 75 lb.....	\$80
Spelter, cents per pound.....	14
Tin, cents per pound.....	43
Zinc-dust, cents per pound.....	20

ORE PRICES

San Francisco, December 26.

Antimony, 50% metal, per unit.....	\$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.....	15.00
Magnesite, crude, per ton.....	6.50—9.00
Manganese, 50% (under 35% metal not desired).....	16.00
Tungsten, 60% WO ₃ , per unit.....	18.00—20.00

Tungsten is to be discussed by the Colorado Metal Mining Association at its annual meeting at Denver on January 9, 10, and 11.

The 'Manganese Number' of the 'Pahasapa Quarterly', published by the South Dakota School of Mines, will be found of value to producers.

New York, December 20.

Tungsten: Germany's peace overture was of great interest to the tungsten trade, in view of the fact that in times of peace she is the largest consumer of the ore. Brokers believe that a cessation of hostilities would for a time, at least, send prices upward. British and French buyers have been active in the past few days, taking ore for prompt delivery and over the first half of 1917, at prices ranging from \$16.50 to \$18 per unit, the latter for choice Argentine ore. A domestic consumer is in the market for a large quantity, and the market is stiff at \$17.50 to \$20, according to grade and position. Thirty of the largest consumers of tungsten in England have combined to build their own reduction works, but have been hampered by a shortage of ore.

Molybdenite: The supply appears to be inadequate to fill the available orders. Large orders for ferro-molybdenum are seeking placement. The quotation for molybdenite is \$1.80 to \$2 per pound.

Antimony: Ore is difficult to obtain, and up to \$1.70 per unit c.i.f., New York, has been offered.

EASTERN METAL MARKET

(By wire from New York.)

December 26.—Copper is dull and steadier; lead is quiet; spelter is steadier but quiet.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.	Average week ending
Dec. 20.....	32.50
" 21.....	32.00
" 22.....	31.25
" 23.....	31.00
" 24 Sunday.....	
" 25 Holiday.....	
" 26.....	31.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	14.21	13.60	24.20	July	13.26
Feb.	14.46	14.38	26.62	Aug.	12.34
Mar.	14.11	14.80	26.65	Sept.	12.02
Apr.	14.19	16.64	28.02	Oct.	11.10
May	13.97	18.71	29.02	Nov.	11.75
June	13.60	19.75	27.47	Dec.	12.75

On February 1 the Granby Consolidated will pay \$2.50 per share, equal to \$374,963. This makes \$7 for 1916.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.	Average week ending
Dec. 20.....	76.62
" 21.....	76.50
" 22.....	75.75
" 23.....	75.75
" 24 Sunday.....	
" 25 Holiday.....	
" 26.....	75.75

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	77.85	74.40	41.76	July	31.60
Feb.	77.85	74.40	41.76	Aug.	31.60
Mar.	77.85	74.40	41.76	Sept.	31.60
Apr.	77.85	74.40	41.76	Oct.	31.60
May	77.85	74.40	41.76	Nov.	31.60
June	77.85	74.40	41.76	Dec.	31.60

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	57.58	48.85	56.74	July	54.90
Feb.	57.58	48.85	56.74	Aug.	54.90
Mar.	58.01	50.61	57.89	Sept.	53.75
Apr.	58.52	50.25	64.37	Oct.	51.12
May	58.21	49.87	74.27	Nov.	49.12
June	56.43	49.03	65.04	Dec.	49.27

Silver valued at \$750,000 was shipped from San Francisco to the Orient on December 22.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.	Average week ending
Dec. 20.....	7.50
" 21.....	7.50
" 22.....	7.50
" 23.....	7.50
" 24 Sunday.....	
" 25 Holiday.....	
" 26.....	7.50

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	4.11	3.73	5.93	July	3.80
Feb.	4.02	3.83	6.23	Aug.	3.86
Mar.	3.94	4.04	7.26	Sept.	3.82
Apr.	3.86	4.21	7.70	Oct.	3.60
May	3.90	4.24	7.38	Nov.	3.68
June	3.90	5.75	6.88	Dec.	3.80

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.	Average week ending
Dec. 20.....	10.25
" 21.....	10.25
" 22.....	10.00
" 23.....	9.75
" 24 Sunday.....	
" 25 Holiday.....	
" 26.....	9.75

Zinc-ore production of the Missouri-Kansas-Oklahoma region in 1916 was estimated to be fully \$35,000,000, a record. Details will be available soon.

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	5.14	6.20	18.21	July	4.75
Feb.	5.22	9.05	19.99	Aug.	4.75
Mar.	5.12	8.40	18.40	Sept.	5.16
Apr.	4.98	9.78	18.62	Oct.	4.75
May	4.91	17.03	18.01	Nov.	5.01
June	4.84	22.50	12.85	Dec.	5.40

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.	Week ending
Dec. 12.....	\$6.00
Nov. 28.....	\$7.00
Dec. 5.....	\$8.00

Monthly averages

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	39.25	51.90	292.00	July	37.50
Feb.	39.00	60.00	295.00	Aug.	38.00
Mar.	39.00	60.00	295.00	Sept.	38.00
Apr.	38.90	77.50	141.60	Oct.	38.00
May	39.00	75.00	90.00	Nov.	38.00
June	38.60	90.00	74.70	Dec.	38.00

TIN

Prices in New York, in cents per pound.

1914.	1915.	1916.	1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60
Feb.	37.85	34.40	41.76	Aug.	31.60
Mar.	37.85	34.40	41.76	Sept.	31.60
Apr.	37.85	34.40	41.76	Oct.	31.60
May	37.85	34.40	41.76	Nov.	31.60
June	37.85	34.40	41.76	Dec.	31.60

Tin is steady at 41 cents.

ANTIMONY

Quotations at New York show considerable irregularity, ranging all the way from 13 75 to 14.50c, duty paid, for Asiatic grades. There is not enough business to actually test the market.

ALUMINUM

The quotation for No. 1 virgin aluminum, 98 to 99 1/2 pure, is unchanged at 63 to 65c. per pound.

Eastern Metal Market

New York, December 20.

Despite the unquestioned sold-up state of producers, who have but little copper to sell in the first half of 1917, the peace talk has unsettled the market and brought out offerings from second-hands. While a good quantity of metal was undoubtedly in speculative hands, they are not the only would-be sellers, for at least a few consumers have placed copper in the hands of brokers. The great quantity sold, however, will undoubtedly act as a bulwark against any radical decline in prices.

Zinc has declined steadily in a quiet market.

Lead prices have dropped sharply, and all interests are now at the same level—7.50c., New York. Where there was a seeming shortage of lead, second-hands are now pressing the metal for sale.

Antimony and aluminum are quiet. While there is a wide divergence of opinion as to what Germany's peace proposal will amount to, it is notable that many factors of the metal trade who have close connections abroad believe that peace is not far off. They base their opinion on the attitude of the Germans themselves. In the past week, for instance, a German banker representing German financial interests in New York has expressed a belief that peace is near. The two largest German trans-Atlantic steamship lines have sent out letters inviting communications concerning freight space and rates "when the War is ended," and letters from abroad show a conservative strain.

The iron and steel market was rendered distinctly quiet when the peace announcement was received, but the quiet was only temporary, and conditions are now much the same as they were before, so far as finished steel is concerned. Pig iron is not so active, but prices have not suffered. The interruption exercised a healthful effect on business, inasmuch as from now on, buyers will not lose sight of the fact that the War must end sooner or later, and will govern themselves accordingly. France and Italy have placed additional orders for steel in the past week. It also may be noted that should a condition arise which would call for the cancellation of war steel, the same tonnage would be diverted to plates, shapes, and bars, for which peace would bring a great demand. Some of the war contracts are stated to have such a proviso.

COPPER

Although the producers assert that their prices have not been changed since Germany's suggestion that she would welcome peace under satisfactory terms, second-hands, including consumers, have offered copper at substantial concessions. It is predicted that the business of the next few months will be done by second-hands, this view being based, of course, on the sold-up state of the producers. As for activity, none of moment is expected this year, or early in 1917. Prices are too high to start a movement of noteworthy proportions, while the sellers are too well filled with orders to let quotations drop far. In far-off positions considerable short selling is reported, indicating that speculators are willing to gamble that prices will be lower in the last half of the year. It is reliably stated that a large mill became so disturbed over the peace talk that it offered 1,000,000 lb. of prime Lake copper last week at 30c. per pound. It cannot be learned that the copper was taken. There has been some business in the past week, mostly for nearby delivery, although August and September was sought also. Generally, the market has been quiet both sellers and consumers being inclined to simply watch developments. It is curious that, whereas prompt copper was so scarce prior to the news from Germany, it is now quite plentiful, a fact only to be accounted for by offerings on the part of

consumers and speculators. January electrolytic and Lake were offered yesterday at 35.50c., and first quarter at 31.50 to 32c., with the latter figure more generally prevailing. Spot was nominally around 34c. While awaiting Lloyd-George's reply to Germany on the 19th, the market was in a nervous state, with thought concentrated on what an early ending of the War would mean. One reassuring theory was that Great Britain would take the 200,000 tons it purchased for delivery over the first half of 1917, but that the metal would be used for industrial instead of war purposes. She now has a firm grasp on the copper within her boundaries and is regulating both the price and consumption, none being used for any purpose except by express permission of the Government. The London quotation for spot electrolytic yesterday was down to £161 against £168 a week previous. Exports from the 1st to 20th total 14,040 tons. It is yet too early to tell just what the copper market is going to do, but a period of dullness is indicated, with second-hands making the sales. They usually will make concessions to get business. Brass and copper products are as strong as ever. Since the beginning of the peace talk one or two Dutch concerns have cabled, asking that shipments to them be hurried.

ZINC

The decline in spelter has continued, and December delivery was sold yesterday at 10c., St. Louis, by second-hands. They also disposed of second quarter at 9.25 to 9.50c., St. Louis. First quarter was quoted yesterday around 9.75 to 10c., St. Louis, the new York quotation ranging about 25 points higher for each position. The situation is unsettled, with little business to be reported. Representatives of some of the producers are quoting above what appears to be the market, insisting that they believe fundamental conditions to be sound, and that January will see higher prices. Of course, those who take this stand are undoubtedly well filled with orders for the next few months. The London spot quotation yesterday, the 19th, was £54 5s., compared with £57 a week previous. Exports in 20 days total 2787 tons, a poorer showing than has been usual of late. Sheet zinc is unchanged at 21c. per pound, f.o.b. smelter, 87 off for carloads.

LEAD

This metal has been acting more or less in company with copper, in that prices have declined and stocks appeared which were not supposed to be in existence. In the past few days the market has entirely reversed itself. On December 11, independent producers were asking 8c., New York, whereas yesterday they quoted 7.50c., New York, and about 7.40c., St. Louis. In the course of the decline second-hand lots were freely offered, showing that a good deal of metal has been held for speculation. The London quotation was unchanged yesterday, the 19th, at £30 10s. Exports from December 1 to 20 were small, amounting to only 122 tons.

TIN

On the 18th about 200 tons changed hands, and yesterday, the 19th, 100 tons was taken, otherwise the market has been quiet since the last report. The buying referred to was confined to a few concerns, and is believed to have been done for the purpose of covering contracts against which tin had failed to arrive. The quotation for spot Straits has weakened during the dullness, and yesterday 42.37½c. was quoted. Should definite steps toward peace be taken, it is thought that the tin market would be benefited, inasmuch as it would mean the earlier restoration of a wider market. Plenty of tin is available. Arrivals in December, including the 19th, amounted to 1070 tons. There are 6393 tons afloat.

Mining Decisions

MINING CLAIMS—TAXATION

The Idaho Statute requiring assessors to assess mining claims by taking the Government price per acre for mineral lands as a basis for valuing the surface, adding the cash value of improvements, and then adding the net output for the preceding year, was held constitutional.

Hanley v. Federal Mining & Smelting Co. (Idaho), 235 Federal, 769. July 22, 1916.

OIL LEASE—EXTENSION VALID

A grantor, having granted an extension of the time a well should be drilled under an oil lease in consideration of quarterly payments, sought to terminate the extension within the term thereof by refusing to accept the quarterly payments when tendered. Held, the extension was binding upon the lessor.

Leonard v. Busch-Everett Co. (Louisiana), 72 Southern, 749. October 16, 1916.

OIL LEASE—FAILURE TO DRILL OFF-SET WELLS

Under an ordinary oil and gas lease where delay rentals were provided for, paid and accepted, there was no implied covenant by the lessee to drill off-set wells to prevent drainage through wells driven on adjacent land, and his failure to do so during the period in which he was paying and the lessor was accepting such rentals does not make him liable for damages on account of such drainage.

Stanley v. United Fuel Gas Co. (West Virginia), 90 Southeastern, 344. October 10, 1916.

ASSESSMENT WORK PREVENTED BY FORCE

Where defendant prevented plaintiff's predecessor in title from performing the assessment work on a mine for a year, driving away laborers and threatening them, defendant, whose location overlapped that of plaintiff cannot base any rights on the failure of plaintiff and his predecessor to perform the assessment work, particularly where there was no showing that there was any part of plaintiff's claim outside the overlap on which assessment work might have been beneficially performed.

Ames v. Sullivan (Alaska), 235 Federal, 880. September 5, 1916.

OIL AND GAS LEASE—UNCONSCIONABLE FORFEITURE ENJOINED

Where an oil and gas lease provided for forfeiture for non-payment of rent, and the lessee after paying rent promptly for 13 years, in the 14th year sent his check so that it reached the lessor the day after it was due and before a forfeiture had been declared, a forfeiture would be unconscionable and the lessor will be enjoined from enforcing it. An oil and gas lease is not a mere license, but creates a corporeal interest in the land which does not divest except through a lawfully declared forfeiture.

McKean Natural Gas Co. v. Wolcott (Pennsylvania), 98 Atlantic, 955. July 1, 1916.

OIL AND GAS LEASE—EXTENSION—DEATH OF GRANTOR

A grantor of an oil and gas lease died, and his widow, being entitled to one-half of his estate and the usufructuary rights to the other half, granted extensions from time to time for additional considerations paid by the lessee. She died before the last extension had expired, and her daughters, being joint heirs to her estate, attempted to have the lease declared forfeited because no wells had been driven within the period

originally contemplated, alleging that their mother's last extension was terminated by her death, because she had had only the usufructuary use of half of the land. Held, that as the daughter's based their title solely on their unconditional succession to their mother's estate they could not avoid the lease.

Cochran v. Gulf Refining Co. of Louisiana (Louisiana), 72 Southern, 718. October 16, 1916.

OIL-LAND WITHDRAWAL—SUBSEQUENT CLAIM VOID

Locators who had expended some \$20,000 in a fruitless attempt to make a discovery of oil, and discontinued work on their claims except for the employment of a watchman, prior to the issuance of the Taft withdrawal order of 1909, cannot vest any title under such attempted location in an assignee who comes in several months after said withdrawal order took effect and actually develops oil. Such an assignee is a mere trespasser on the domain of the United States, and will be enjoined from further work and a receiver appointed to take charge of further operations.

United States v. McCutchen et al. (California), 234 Federal, 702. July 12, 1915.

QUARRY LEASE—IMPLIED COVENANT

A quarry lease for "as long as the property is suitable for quarrying purposes," and providing for royalties per cubic yard of stone excavated, by implication obligates the lessee to work the quarry or sustain the burden of proof in a suit for royalties that the quarry cannot be profitably worked. The mere fact that it would require larger machinery than that which had been installed by a previous lessee does not excuse his performance. If the rock is shown to be there, he will be held to his implied covenant to excavate it or to pay damages for failure so to do.

Stoddard v. Illinois Improvement & Ballast Co. (Illinois), 113 Northeastern, 913. October 24, 1916.

MINING CONTRACT—CONSTRUCTION

A mining contract required the purchaser to pay a percentage of the net profits thereunder, after deducting from gross receipts the actual expense of labor including wages, team-hire, and board. Held, that such language did not include permission to deduct the cost of materials and supplies such as shovels, picks, and lumber. Nor, if the purchaser departed from the methods of mining originally contemplated by the agreement for the purpose of employing the more economical hydraulic method, was he entitled to charge more than the stipulated price for water, although the high-pressure water, necessary for hydraulic mining, might as a matter of fact cost more.

Blanc v. Pioneer Mining Co. (Washington), 159 Pacific, 1077. September 15, 1916.

IRON-MINING LEASE—CLAUSE CONSTRUED

An iron-mining lease, providing for minimum ground rents in substantial amounts, contained a clause to the effect that the lessee should "work the mine or mines now or hereafter discovered on said lands in a good workman-like manner during the existence of the lease" and that forfeiture should be had for failure of the lessee to "work such mine in a good workman-like manner or fail to pay the ground rent when due." For 10 years lessees paid and lessors accepted the minimum ground rent, but no work other than prospecting was done. Held, on suit by lessor for forfeiture that the above clauses only required "good and workman-like work" if any work was undertaken, but did not obligate the lessee to keep up mining operations so long as he paid his ground rent.

Niles Land Co. v. Chenung Iron Co. (Minnesota), 234 Federal, 294. April 28, 1916.

Book Reviews

MINING AND MINE VENTILATION. By Joseph J. Walsh. P. 180. Ill. and index. D. Van Nostrand Co., 25 Park Place, New York, 1915. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$2.

The author of this book had a large practical experience in matters of mine ventilation in a region, Wilkes-Barre, Pennsylvania, where this is a positive necessity. Here he has written a treatise both interesting and valuable. There is given a method for determining the size of fan or blower required to ventilate a mine under given conditions. There is also a chapter on mine fires which will interest all mining men, and the chapter on mine lamps is also of value and full of common-sense suggestions.

FLOW OF WATER IN PIPES. By George T. Prince. P. 149. Charts and tables. D. Van Nostrand Co., New York, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, \$2.

The notes and tabulated data in this book refer to the flow of water under pressure through clean, closed pipes, collected by the author while chief engineer for a water-supply company at Denver, Colorado. In that city there is over 100 miles of continuous wood-stave pipe from 30 to 48 in. diam. The importance of pipe-design was investigated, and flow-data were compared with accepted formulae, five of which were selected by means of which 123 pages of tabulated values were computed. Therein is calculated the fall, velocity, and discharge from pipe 4 to 120 in. diam. Thirteen pages discuss formulae, and nine plotting flow-data by means of logarithms. Hydraulic engineers should find this little book of service.

TREATISE ON HYDRAULICS. By Mansfield Merriman. Tenth edition. P. 556. Ill., index. John Wiley & Sons, Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$1.

In the latest edition of this standard work, a considerable part has been revised or re-written and considerable new matter added. The more important additions include a complete table of values for n in Kutter's formula, based upon Horton's recent experiments and a discussion of the newer types of hydraulic turbines. The chapter headings are Fundamental Data, Hydrostatics, Theoretical Hydraulics, Instruments and Observations, Flow through Orifices, over Weirs, through Tubes, through Pipes, in Conduits, Flow of Rivers, Water Supply and Water Power, Dynamic Pressure of Water, Water-Wheels, Turbines, Naval Hydromechanics, and Pumps and Pumping. The hydraulic tables are placed in the text next to the explanation of their use, but a special index of the tables facilitates reference.

THE FUNDAMENTAL PRINCIPLES OF PETROLOGY. By Albert Johannsen, translation from the German work by Dr. Ernst Weinschenk. P. 211. Ill., index. McGraw-Hill Book Co., Inc., New York, 1916. For sale by the MINING AND SCIENTIFIC PRESS. Price, \$2.50.

This work, recently translated from the original German, will prove of great value to the students of petrology. Its title is, perhaps, somewhat misleading, as it is in no sense a treatise on microscope petrography, but a clear and comprehensive dissertation on the character of rocks—what they are, and how they came to be as they are found. It deals with the solidified crust of the earth and the rocks that comprise it, and particularly with the alterations to which rocks have been subjected and the causes therefor: the composition of igneous rocks; rock-weathering processes and their results; the nature of sediments and the metamorphism of sedimentary and other rocks, and post-volcanic processes. An understanding of these

subjects cannot fail to be of value to any student who desires to become proficient in the study of rocks, either microscopically or otherwise. The book is profusely illustrated.

LABORATORY MANUAL OF BITUMINOUS MATERIALS. By Prevost Hubbard. P. 153. Ill. John Wiley & Sons, Inc., New York. For sale by MINING AND SCIENTIFIC PRESS. Price \$1.50.

The title of the book states that it is for the use of students in highway engineering. This doubtless includes the many engineers now engaged in highway construction who completed their technical training before highway engineering became recognized as a special subject, and who, as well as the college student, will find the present volume of value. Part I gives a general discussion of bituminous materials. Part II describes in detail the various tests and the different methods used for making these tests. Part III gives the characteristics of the more important bituminous materials. A number of blank pages for notes are included with the text.

CONTRACTS, SPECIFICATIONS, AND ENGINEERING RELATIONS. By Daniel W. Mead. P. 518. Ill., index. McGraw-Hill Book Co., New York. For sale by MINING AND SCIENTIFIC PRESS. Price, \$3.

The divisions of this book that treat of contracts and specifications are similar in character to several other treatises on these subjects that have appeared during the past few years, although the treatment is perhaps more complete in the present volume. The division dealing with engineering relations, which includes presumably the chapters on The Engineer and His Education; Success in the Engineering Profession; The Engineer at Work; Personal and Ethical Relations; The Use of English; Letters and Reports; Origin, Nature, and Development of Law; Some Legal Relations of Technical Men; and Legal Rights and Responsibilities, is largely devoted to matters that have never been discussed so thoroughly before. It is also true that discussion of a number of subjects that is usually found scattered among a number of volumes is here grouped so that the relation between them is clearly shown. It has frequently been pointed out that the work of the true engineer deals with men as much as with materials and machines. We know of no book better suited to guide the young engineer in his relations with men than the present volume. However, the book is of value to the experienced member of the profession as well as to the student and young engineer. The older engineer will probably find a good deal that he did not know before, besides being able to use the volume as a reference book to make sure that he has omitted nothing in the preparation of an important set of specifications.

Following the chapters already mentioned, there are several that comprise a brief but complete discussion of the law of contracts as applied to engineering and construction matters, not befogged by unnecessary legal terms. The sections dealing with specifications discuss the general principles underlying specification writing and then proceed to the consideration of specifications for particular kinds of work and materials. Here also the emphasis is laid upon the objects to be attained by each clause in the specifications, rather than upon the wording of particular sections. In fact, special attention is paid to the danger of copying specifications used on some other work without making sure that each clause is applicable to the work in hand. There are four appendices. The first contains outlines of specifications for several different kinds of construction. The second contains a sample contract and specifications for a complete structure, in this case, a concrete reservoir and suction-well. The third contains a number of examples of drawings that may be used in connection with specification writing. The fourth is a classified bibliography, whose completeness may be judged from the fact that it comprises 50 pages.





